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Meeting Emerging Ecological, Economic and Social Challenges in the Great Lakes region:

Popular Summaries

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Meeting Emerging Ecological, Economic and Social Challenges in the Great Lakes region:

Popular Summaries

Great Lakes Forest Alliance
2003 Summit

Compiled by

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Abstract

Here we provide a compendium of summaries of the concurrent session and poster presentations from the June 2003 Great Lakes Forest Alliance's *Second Annual Sustainable Forest Management Summit: Meeting Emerging Ecological, Economic, and Social Challenges* held in Sault Ste. Marie, Ontario, Canada.

The goal of the summit was to provide a broad forum to critically discuss emerging forest resource issues in the Great Lakes Region and a venue for natural resource professionals and stakeholders to exchange views and network on sustainable forestry issues. Topics include:

- economic issues such as certification, criteria and indicators of sustainability, and value added forest products;
- social issues such as environmental education, involving private landowners in developing strategies for sustainable forest management, and sustainable use; as well as
- ecological issues such as climate change, riparian zone management, and maintaining wildlife habitat.

Acknowledgements

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PRESENTATIONS

Potential Forest Industry Growth Sectors Within the Great Lakes Forest

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Introduction

This presentation provides an evaluation of some of the dominant market trends in the North American forest product sector and the implications of these market dynamics on growth in the timber-consuming industries of the Great Lakes region.

Discussion

Over the coming decade, the forest products sector of the Great Lakes Forest Alliance (GLFA) region will be contending with extremely challenging conditions. The prevailing market trends that will be affecting the entire North American industry include:

- Maturing domestic markets for paper, lumber, and structural panels
- Excess capacity
- Growing competition from offshore suppliers

In this tough business environment, new investment will be targeted to those products that have demonstrated the potential to access new markets and/or gain a growing share of existing markets based on superior performance or cost advantages. Over the past decade, a number of products have been able to buck the general trend in the North American forest products industry, expanding their market presence and attracting investment capital. In the solid wood sector, the two most prominent have been oriented strandboard (OSB) and engineered wood products. The potential for investment in OSB and engineered wood products in the Lake States and Ontario is likely to be more limited than in the past decade for a number of reasons:

- OSB is already the dominant structural panel in residential construction, and future growth in OSB will be more dependent on gaining market share from plywood in the more difficult R&R and specialty industrial markets.
- Offshore structural panel imports are still rising.
- The closure of pulp capacity in the U.S. south and West Coast coupled with the maturing of intensively managed plantations have increased possibilities for locating new mills in other North American regions.
- Lower and less volatile pricing for softwood lumber will make engineered wood products less competitive with lumber and slow the rate of market penetration for wood I-beams and strand lumber.

In the North American paper industry, tissue and lightweight, coated papers have been able to sustain stronger market growth than most other grades. Over the next five years, this group of products will continue to expand production, but questions remain if the forests of the Great Lakes region will have a significant role in providing wood fibre to these particular paper products. With excess capacity existing in most grades of paper, the construction of new greenfield paper capacity in North America is not likely in the next decade. Even investment in expanded production at existing facilities will be limited to those facilities that have a distinct competitive advantage in their market segment.

- A key competitive advantage of paper producers in the Great Lakes region is their geographical proximity to the large publishing markets in Chicago. However, the major commodity publication grades of paper (which are also among the dominant grades produced in the Great Lake region) are experiencing increasing competition from Asian and European producers.

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- The publication paper grades that are experiencing the strongest growth and the least competition from offshore producers are the lightweight, coated grades. These paper grades require a higher proportion of softwood (preferably spruce) in their fibre mix, and are not able to capitalize on the abundant hardwood resource of the Great Lakes region.
- Tissue production is also expected to maintain healthy growth in the coming decade, but a significant portion of the future expansions in tissue production will be based on utilizing recovered paper and will probably have only a moderate effect on regional timber demand.

Given the potential limitations on new investment in the forest products sector, public agencies have opportunities to assume an expanded role in encouraging investment in existing operations and attracting new firms to the GLFA area.

- A very large proportion of the region's timber resource is administered and managed by public agencies, which will continue to have a major role in assuring the long-term availability of wood fibre to the region's forest product companies.
- Public agencies can contribute to improving the attractiveness of the region's business environment through a variety of avenues, such as upgrading the regional infrastructure; providing educational/training opportunities; and providing assistance to firms in locating and establishing new projects.
- Public agencies can also help by fostering a cooperative rather than an adversarial relationship with industry in resolving regulatory and environmental issues.

Conclusion

The prospects for growth in the forest products sector of the Great Lakes region over the next 10 years will be challenging in light of more moderate growth in domestic demand and rising international competition. To formulate a strategy to direct new investment to the GLFA region will require a clear understanding of: which specific product areas have the greatest potential for future growth; what competitive advantages the GLFA region can bring to these products; and what aspects of the region's business environment can be improved.

Notes

The Development of a Sustainable Forestry Strategy for Gogebic County, Michigan

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Introduction

Gogebic County is a rural county located in the Upper Peninsula of Michigan. It is the western-most county in Michigan, bordered on the west and south by Wisconsin and on the northwest by Lake Superior. Eighty percent of the county is forested. The forests largely comprise aspen, birch, maple, and softwoods. Forests have historically played an important role in the economic health of the county, for both timber production and recreational purposes. Economic development planners have long recognized the importance of these forests in sustaining community life within the county.

How the project started

In the course of developing a multi-year strategic plan in 1998, the Gogebic County Economic Development Commission brought together a group of 29 county residents representing a broad cross-section of the community to define a vision for the county. The group was challenged to identify strategic goals and related specific projects to move the community closer to realizing these goals. One goal that was identified was to coordinate uses and users of the county's natural resources. To move towards that goal, a project was adopted to define sustainable forestry for Gogebic County. The initiative was driven by the desire of community planners to own the process and to enfranchise local voices regarding local forestland issues.

As a first step, a steering committee in Natural Resources was established in February 1999 to serve primarily as the data gathering and coordinating group. The committee agreed that the economic, ecological, and social aspects of sustainable forestry were to be considered within the scope of sustainability. The need for assembling economic data was paramount. Although some data on forest resources were acknowledged to be readily available, other data such as social and cultural, are not. The group agreed that the economic aspect of forestry was to be given priority, but at the same time knowing that it was important to harmonize it with the ecological and social aspects to promote sustainable resource use over the long term.

The steering committee agreed that there was a need for a "large, diverse, community-based organization." As a result, a community group was formed to provide continuous input and feedback from the larger community. The group was called the Forest Advocacy Coordinating Team (FACT) and was charged with helping to identify and address forest-related issues in Gogebic County.

FACT's mission was to agree upon a vision for sustainable forestry in Gogebic County in the long run, based on data for past and present trends. The group was also charged with mediating and advocating for the County in forest issues using recognized facts as the basis for its positions. A key responsibility of FACT was to educate the public about the role of forestry and inform the community about the need to sustain the value of forests for the future of the County.

The FACT group met in June 1999. As a first step, the group developed a draft definition for

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sustainable forestry in the County. Given the diversity of views represented by FACT members, this was not a simple task. The definition that they reached consensus on was: *Sustainable Forestry in Gogebic County is (forest management) that contributes to the (economic health) of Gogebic County while maintaining the (ecological and social/cultural values) for the benefit of present and future generations in Gogebic County.*

To reach this consensus, they made the strategic decision to put several phrases in brackets. These were phrases that would need further refining but that they could all agree on initially without spending too much time debating actual definitions.

To further refine these four terms, FACT decided to use the Montreal Process Criteria and Indicators (MP C&I). Initially the group focused on developing socio-economic indicators assisted by the Michigan State University Extension Program. The next step was to expand the focus and include some ecological indicators to evaluate the health and productive capacity of local forests. This led to the idea to use the "Linking Communities to the Montreal Process" Tool Kit (Developed by Sustainable Measures, Inc.)

Using the Montreal Process Criteria and Indicators (MP C&I)

Gogebic County was particularly interested in using the MP C&I for two main reasons:

(a) to refine their definition and the four bracketed terms by selecting criteria and indicators;

(b) to use these indicators to measure their progress towards the vision of sustainable forestry in the County.

The intent was to either adopt existing criteria and indicators or develop local criteria and indicators that would help accomplish the above tasks.

In two workshops in November 2001, organized by FACT, participants from Gogebic county developed a draft list of principles and sustainability indicators for measuring economic, environmental, and social conditions, pressures, and activities as they relate to sustainable forestry efforts.

Finalizing indicators

The steering committee met twice, in January and April 2002, to finalize the list of indicators for Gogebic County, and to develop recommendations for proceeding with the work. The definition of sustainable forestry in Gogebic County was finally agreed upon by selecting a small set of indicators for each of the four-bracketed terms (economic health – 4 indicators, forest management – 4 indicators; ecological values – 5 indicators; social/cultural values – 6 indicators).

Lessons learned

The Gogebic County initiative for sustainable forestry provided some key lessons that other communities may find valuable. These are briefly listed and discussed below.

- It is overambitious to try to do both sustainable community and sustainable forestry indicators simultaneously under the MP C&I. The latter is specifically designed to address forest issues and leaves very little space for other social and economic issues, such as education, civic engagement, public health, etc. While these are important aspects of any community, trying to develop indicators to cover each of them leads to a long list that is extremely difficult to manage. The MP C&I is most suited for communities with a strong interest in or concern for forest-related issues.
- Some of the indicators in the MP C&I set are not meaningful at the local level. There is clearly a need for upscaling and downscaling the indicators, or identifying which indicators at national level can be used locally and which ones at local level can be integrated up to the national scale. Creating a tiered system of indicators at different scales (local, regional, multi-state, and national) is particularly important both for improving data collection and decision-making at all these levels to promote sustainable forestry.

- There is no one set of indicators that will apply to every community (one size-fits-all). Depending on their resources and key issues, communities should be able to select the most relevant indicators to measure their sustainable forestry efforts.

- The workshops in Gogebic County demonstrated that community indicator projects are processes and not endpoints. A community cannot expect all the answers and a perfect set of sustainable forestry indicators from one meeting. First, involving diverse community representation often involves a series of discussions to reach consensus. Second, public education and raising awareness about the importance of preserving forest resources is more important than simply coming up with a sophisticated set of indicators. Third, as a community changes over time, its key issues may also change. This requires continuous revisiting of the goals and indicators of sustainable forest management.

- Indicator projects should include a wide group of people representing diverse interests in the community. This helps to build ownership within the community and to overcome the institutional and policy fragmentation that results from multiple land ownership, mandates, legislation, and policies. Moreover, diverse community support for the project helps to ensure that the initiative will continue even if critical members move on.

- There is a clear need to identify data and information sources that communities can use in measuring and tracking the indicators. Data collection can be time-consuming and expensive as some of the information is place specific. For example, to measure some of the social and cultural values in the community, Gogebic County initiated a comprehensive residents survey designed and conducted by the Department of Forestry and MSU Extension, Michigan State University.

Gogebic County is clearly an example of a community that did not have outside resources but managed to engage the entire community and come up with a common vision for sustainable forestry. This demonstrates that even small communities with limited resources can accomplish a lot by defining a common vision and goals, initiating action, and measuring progress.

Notes

Michigan Forest Association Programs Affecting Forest Sustainability

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This presentation outlines an educational program and a combination educational and legislative program carried out by the Michigan Forest Association that has the potential to influence forest sustainability in a positive way. We describe how the two programs developed over time as an example of what worked and what did not work that other individuals and organizations may find helpful in their own endeavors. There are no statistical results. We simply report what was done and our assessment of what worked well, what did not, and what we expect in the future.

Green Gold: Michigan Forest History

When working with the Michigan Department of Natural Resources, Bill Botti got a call from a teacher requesting educational materials that were non-existant at the time. Bill is a talented artist and he authored and illustrated what he intended as a coloring book for elementary students. Bill will describe what he went through to produce *Green Gold: Michigan Forest History*, a 44-page booklet describing the history of Michigan forests from the time of the glaciers, through European settlement, land clearing and nation building, heavy logging, rampant fires, forest devastation, the conservation movement, and reforestation to today's healthy and productive forests.

The first printing of 1,000 copies was done by the Michigan Forest Foundation (MFF) through a grant honoring Paul E. Dake, the first President of MFF, and had in small print on the front cover "A coloring book." The booklets were distributed to about 200 teachers on the then current MFF teacher mailing list. The teachers informed us that the booklet was a poor coloring book (there were not enough enclosed spaces within which young students could color), but it was a super forest history booklet. Besides, use of the term coloring book would apparently turn off any students older than kindergarten. To date, 34,000 booklets have been printed by MFF and most of them have been distributed free to schools through industrial grants. The majority of the booklets have been used in 4th grade classes studying Michigan history, which is part of the 4th grade public school curriculum.

At the beginning of the program, MFF furnished enough booklets for all the students in classrooms that requested them. It soon became evident that, with the limited funds available, we would be a long time reaching all the schools in the state. Funding was found, a video with the same title was produced, and we changed the program to furnish 1 video and 5 booklets per school. MFF had problems getting information to schools about the availability of the booklets. Our first promotional effort was to fax all the school districts with information about the program with an order form at the bottom. Based on the limited number of orders, it was obvious that a different approach was needed. By phoning the schools and talking to an interested teacher, principal, or curriculum coordinator, we obtained four or five times the number of requests.

After several years of distribution, we made a limited number of school contacts to determine whether the booklets were being effectively used and uncovered the disappointing fact that at least half of the contacts indicated that people in the schools contacted did not even know whether the booklets were still available. Finally by contacting the Michigan Department of Education, we learned that curriculum guidelines

had just been changed and that the booklets covered much of the information needed to meet the late elementary guidelines for social studies. The next printing included a list of the guidelines met by the booklet, and when we informed educators, a surge of new orders followed.

The Green Gold videos and booklets were produced and distributed to schools with the idea that, if children learned early the multiple benefits of good forest management, they were more likely to make good decisions about the use of our forests as adults. We believe that this will happen and will promote social sustainability of our forests. We still have much work to do to make this information available to all Michigan schools on a continuing basis.

Private Land Taxation

The second Michigan Forest Association (MFA) program that should help to promote forest sustainability is an ongoing effort to have private forested land taxed at a rate that will permit owners to continue to practice forestry without having to sell the land to make ends meet. Several laws have been in effect that helped some owners with equitable taxes, but left other landowners without help for various reasons.

The Commercial Forest Act has benefited especially large landowners with current taxes of $1.10 per acre ($2.72 ha^{-1}) per year with an additional $1.20 paid by the state. Most of the land enrolled is owned by industry. Since the act requires that enrolled lands be open to the public for hunting and fishing on access by foot without any restriction by the landowner, many landowners choose not to enroll. Approximately 2.3 million of Michigan's 19 million forested acres are enrolled in this program.

The Private Forest Reserve Act is a very old law that applied only to a maximum of 40 forested acres (16 ha) that were part of a farm of not over 160 acres (65 ha). Since records on this program are not kept on a statewide basis, no one knows the exact extent of the program, but it is insignificant compared to the Commercial Forest Act acreage.

The Farmland and Open Space Preservation Act (Public Act 116 of 1974) has some benefits for forested land that is part of a farm but does not apply to forested areas not part of a farm.

When a new tax law was passed in Michigan in 1994, forest owners were delighted when they read that Tree Farms would be taxed as agricultural. The enthusiasm quickly faded when they read further and learned that the definition of "Tree Farm" applies only to horticultural operations and Christmas tree farms and specifically excludes parcels where timber is being grown for commercial harvest. The Michigan Forest Association and other organizations tried unsuccessfully to get the definition changed before passage of the new act.

Last year a bill was introduced in the Michigan legislature that would have required that managed forests be considered and taxed as agricultural. It did not get to a vote, but has been reintroduced in this session of the legislature.

The decimation of Michigan's forests in the late 1800s and early 1900s was due in large part to poor taxation policies. Cutover forest land was taxed at the same rate as land with standing timber. Prudent land owners and mill owners calculated the cost of taxes and other expenses to maturity and decided they could not make a profit if they replanted the cutover areas. Many forest landowners are now having their forest land reclassified as residential with significant increases in taxes. One MFA member who owns an abandoned farm growing up in brush decided to plant trees on about 200 acres to make better use of the land. The brushy areas are still taxed as agricultural but he is now paying residential taxes on the planted area, which he cannot afford to continue. In the most extreme case we know of, one MFA member is paying taxes of $9,875 per year on an 8.6 acre parcel ($1,148 per acre or $2,837 ha^{-1}) that is 100% wooded and surrounded by highly developed land.

Since two of the concerns about sustainability are forest fragmentation and conversion to other uses, MFA believes it is critical to tax land equitably to make it financially possible for owners to maintain land in forestry. We believe we have the support of the Michigan Farm Bureau, the Tree Farm program, and many other organizations and individuals and we will continue to work to achieve equitable taxation for private forest land. We are pleased that MFA was invited to give input to the newly appointed Michigan Land Use Leadership Council.

MFA also believes that it is critical that citizens understand the benefits of good forest management. If enough people believe that timber harvest is equivalent to forest devastation, we will lose much of our economic base and a substantial portion of the forest products we need and use on a daily basis. We must do a better job of forest education if we are to achieve forest sustainability.

Notes

Riparian Forest and Nearshore Fish Habitat in Ontario: So Close and Yet so Far

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Introduction

Ontario has an estimated 260,000 lakes, or about 1 lake per 4.1 km^2. Surrounding these lakes are thousands of kilometres of riparian zone. In central Ontario most riparian zones are forested and a significant but unknown proportion are undeveloped. Lake shorelines support multiple and sometimes competing high values, including plant and animal habitat, recreation and aesthetics, property development, as well as commercial forest products.

Some of the more important policy and guideline issues that are relevant to riparian zone management in Ontario are:

- applying Canada's Federal Fisheries Act
- applying Ontario's Crown Forest Sustainability Act
- managing forests within the riparian zone
- emulating natural disturbance
- sustaining provincial and regional wood supply
- sustaining fishing opportunities
- protecting fish and wildlife habitat
- conserving biodiversity
- remaining conscious of shoreline development capacity

The Canadian Fisheries Act states that there can be no net loss of productive capacity of fish habitat due to management or development activities. Since productive capacity is very difficult to measure and monitor, the act is enforced mainly through habitat management. This relies on the assumption that loss or significant degradation of habitat would reduce productive capacity, and conversely, that increase or improvement in habitat would increase productive capacity. Until recently, however, these assumptions have not been tested in systematic, controlled whole-lake experiments.

Forest harvesting in central Ontario riparian zones was common in the 19th and early 20th centuries. Since then, riparian zones have usually been protected as aquatic buffer zones. Recent revisions to Ontario's *Timber Management Guidelines for the Protection of Fish Habitat*, which are not yet released, will probably allow greater latitude in forest management planning for partial harvesting of trees in riparian zones. It is assumed that partial harvesting of some riparian forests, with application of conservation and other reserves as needed on a site-specific basis, will not negatively affect adjacent aquatic habitat productive capacity. It is also assumed that well-planned selective harvesting will adequately emulate natural disturbance patterns and rates, and provide adequate compliance with Ontario's relatively new *Forest Management Guide for Natural Disturbance Pattern Emulation*. Neither of these very important assumptions has been experimentally tested in central Ontario.

Case Studies of Riparian and Nearshore Habitat and Ecological Process

One important habitat feature that nearly all of central Ontario's undeveloped lakes have in common is an abundance of coarse wood in the nearshore zone of the lake. Coarse wood is defined as pieces of wood that are on the ground or in the water, and have a minimum cross-sectional diameter of 10 cm. In a progressive series of studies over the last 10 years, a team of researchers from the provincial

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Ministry of Natural Resources (OMNR) and the federal Department of Fisheries and Oceans (DFO) have been studying central Ontario riparian forest and nearshore zones, especially coarse wood and its value as fish habitat.

In one set of studies on the ecology and dendrochronology of shoreline coarse wood, we discovered that eastern white pine can sometimes live to more than 500 years, nearly 100 years longer than the age cited in most silvics references. We also found that white pine coarse wood is extremely resistant to water penetration. When combined with its large diameter and long logs, the result is coarse wood that remains intact, buoyant, and even relatively mobile in lakes for as much as 7 to 8 centuries after falling in. When they float about, pine logs often drift to the downwind lake shoreline, often to slightly concave shoreline areas, and in a relatively parallel orientation to shore. These logs tend to remain buoyant, and may support quite complex organic soil deposits and rooted plant communities.

In contrast, eastern hemlock has a relatively high water content soon after falling into a lake. Although hemlock is also quite resistant to decay, once its fine branches deteriorate, these logs tend to sink to the bottom of the nearshore zone and remain generally perpendicular to shore for up to 500 years.

Other conifer species such as red pine, cedar, and spruce can also have long residence times. To date the oldest sample we have found is a red pine with an estimated pith date of A.D. 850 and an outside ring date of about A.D. 1200. Hardwoods common in the riparian zone, for example yellow birch, paper birch, and red maple, have shorter average lifespans, smaller average diameters and heights, and much shorter average residence times than most conifers.

One of our early objectives was to determine if an easily measured coarse wood parameter was correlated with nearshore zone longevity. This objective has not really been met, with the laborious method of cross dating the wood samples being the only reliable way of establishing residence times.

More recently our group has been studying the ecological processes and interactions between riparian and nearshore coarse wood and whole-lake fish abundance and productivity. In 2003 we are conducting a 5-year remeasurement of riparian zone tree mortality and wood input into lakes. To our knowledge this study will provide the first empirical estimates of coarse wood input into lakes. These estimates will provide baseline rates and wood quantities for applying the natural disturbance emulation guidelines, and will help to set baseline and threshold wood level estimates for aquatic habitat assessments.

Another important result of our work is the discovery that our management activities in riparian zones can have a long-term and cumulative effect on the nearshore zone. In our analysis of shoreline coarse wood in several Algonquin Park lakes, with more than 20 km of shoreline sampled, we have evidence that no large white pine logs have fallen into the water since about 1895. This date corresponds to the creation of the park in 1893 and the end of white pine logging along shorelines. Until that time, all merchantable white pines within the watershed, including the riparian zone, were cut. Only small diameter trees, which have a low probability of dying and falling into the water as coarse wood, were left. The current riparian zone pines are generally less than 150 years old, and may live for another 100 or more years before resuming a pattern of natural mortality and nearshore wood input.

As the new Timber Management Guidelines for the Protection of Fish Habitat are implemented, careful monitoring and adaptive management are necessary to ensure that selective riparian zone tree harvesting does not remove a disproportionate share of the largest diameter conifers. Doing so could exacerbate the already interrupted cycle of pine and spruce coarse wood input into many lakes that has occurred for the past century.

Our team is also carrying out the only known whole-lake experimental test of the assumed habitat-fish productivity relationships in Ontario, and possibly Canada. Several years ago, we removed all coarse wood on 50% of the shoreline of 3 undeveloped study lakes in the Algoma region of Ontario, just north of Sault Ste. Marie. Whole-lake fish abundance, size class distributions, reproductive success and productivity, as well as water quality and chemistry were repeatedly measured before and after the treatments. Most effects on lake water were very subtle and short term. The most significant fish community change after 3 years has been a reduction in small fish and an increase in larger fish abundance. Although these results are preliminary, our tentative conclusion is that with less shoreline habitat, smaller fish are more susceptible to predation.

Conclusions and Recommendations

Increased emphasis on understanding and emulating natural disturbances and other ecosystem processes in Ontario requires that we undertake more research in areas like riparian and nearshore zones; ecotones or transitional areas that have not been well studied in the past. Several outstanding ongoing or new studies by the OMNR, the Canadian Forest Service, as well as by other agencies in Alberta, British Columbia, Wisconsin, and elsewhere, will advance our understanding of these complex and highly diverse ecosystems in the coming years. Ontario has taken some significant steps towards recognizing these land-water ecotones as more than just buffer zones to protect the water from our upslope activities. However, stronger linkages are required between our management policies and the ecological processes that are necessary to sustain the ecosystems, communities, and target populations of interest. Many other North American jurisdictions are ahead of Ontario in implementing more holistic riparian zone management guidelines.

Some researchers working in this area are concerned about the relative emphasis being placed on aquatic habitat management. Although habitat management is clearly important, strong evidence is emerging from our studies and others that our angling regulations may need to be addressed if maintaining a productive inland lake fishery is our goal. Before anyone calls for a review of or a major shift in angling policies, we need solid experimental results from our habitat-productivity studies to provide evidence of whether or not habitat is the limiting resource in our undeveloped lakes. This includes not only studies of riparian and nearshore processes that will provide a better understanding of the associated habitat attributes, but also observational studies of the fish and other organisms' empirical use of those habitat features.

Notes

Rapid Growth in Rural Communities and Views of Public Land and Forest Management

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Introduction/Objectives

Amenity rich rural regions, those places with an abundance of scenic and recreation qualities such as mountains, forests, and proximity to water, have been experiencing dramatic social and economic transformations over the past 30 years across the United States. Many of these amenity rich areas have experienced substantial population growth, largely due to in-migration (McGranahan 1999, Johnson and Fuguitt 2000). The demographic transformations in these rural areas have implications for the management of neighbouring public lands as changing rural populations may have different values and views toward natural resources and public lands. Newly arrived residents (newcomers), drawn by the environmental quality, scenery, and outdoor recreation opportunities, have been found to be more supportive of protective management strategies for surrounding public lands rather than commodity production (Rudzitis 1999, Beyers and Nelson 2000). In addition, some amenity regions are destinations for seasonal residents. Seasonal residents, like many newcomers, are drawn to these regions by the natural amenities and tend to be more supportive of protective management strategies and environmental protection than existing year-round residents (Green et al. 1996, Halseth 1998, Rudzitis 1999).

Our study focuses on the Pine Barrens Region of Burnett and Washburn Counties of Wisconsin. These two counties are particularly rich in natural amenities, with over 1,400 lakes and thousands of acres of forest. Located within a two-hour drive of the Minneapolis-St. Paul metropolitan region, the Pine Barrens is a highly desirable setting for second home development, retirement, and ex-urban development (see Table 1).

Approach

Data were collected from self-administered questionnaires distributed via mail to a random sample of 800 landowners in the Pine Barrens of Burnett and Washburn counties, Wisconsin. A modified version of Dillman's Tailored

Table 1. *Selected demographic and physical characteristics of study counties.*

Characteristic	Burnett County	Washburn County
Population, 2000	15,674	16,036
Percent Population Increase, 1990-2000	20	16
Percent Population Increase, 1970-2000	69	51
Percent Seasonal Housing Units, 2000	45	35
Percent Change in Seasonal Housing Units, 1970-2000	76	112
Number of Lakes	508	961
Land Area in Public Ownership, Acres (% of County)	182,462 (32)	156,000 (30)
Land Area Forested, Acres (% of County)	366,544 (64)	347,328 (67)

Buse, L.J. and A.H. Perera (comp.). 2003. Meeting emerging ecological, economic, and social challenges in the Great Lakes region: Popular summaries. Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. For. Res. Inf. Pap. No. 155.

Design Method (Dillman 2000) was used to implement the survey. The overall response rate was 82.8% (n=653) with comparable return rates for seasonal residents and year-round residents of 85.4% (n=317) and 80.4% (n=336), respectively.

The independent variables analyzed were type of residency (seasonal/S or year-round/Yr) and length of residency. Length of residency was analyzed as a categorical variable with respondents owning property in the area for less than 12 years categorized as newcomers (N) and those whose tenure equaled or exceeded 12 years classified as long term residents (Ltr).

Dependent variables were landowner responses to a battery of questions asking them to rate the importance of various management goals for the public lands[1]: timber production, hunting opportunities, recreational opportunities (other than hunting), wilderness values, endangered species protection, and beauty and aesthetics.

Data were analyzed with Chi-Square tests for independence and Cochran-Mantel-Haenszel (CMH) tests — CMH tests are analogous to a one-way ANOVA for ordinal categorical data (Agresti 1996). We tested for differences in rating of importance of management goals between type and length of residence.

Results and Discussion

Examination of sociodemographic characteristics reveals that seasonal residents have noticeably higher income and higher levels of formal education than year-round residents. New seasonal and permanent residents have marginally higher incomes and levels of education compared to their respective long-term counterparts.

Examination of attitudes towards land management goals reveals that landowners, regardless of type or length or residence, place more importance on amenity, non-commodity management goals than on commodity goals (Figures 1 and 2; for ease of presentation only response means are shown). However, when comparing year-round and seasonal residents we see that year-round residents assign a higher level of importance to commodity management

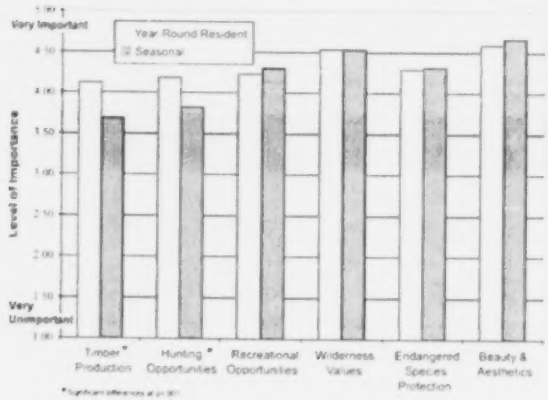

Figure 1. *Importance of management goals for year-round versus seasonal residents.*

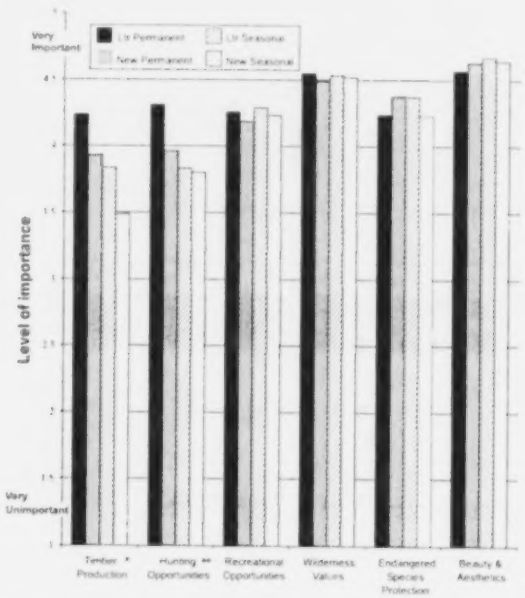

Figure 2. *Importance of management goals compared for length and type of residence.*

[1] The survey question read: "The following are some possible management goals for the public lands in northwestern Wisconsin. Please indicate how important or unimportant each goal is to you." Response categories were "Very Important, Somewhat Important, Neither Important Nor Unimportant, Somewhat Unimportant, Very Unimportant."

goals (timber and hunting opportunities) than seasonal residents (see Figure 1). In addition, newcomers (both seasonal and year-round) place less importance on timber management than long time residents (See Figure 2).

Conclusions

This study provides evidence that there are important similarities and differences between residents of the Pine Barrens communities. Overall, more importance is placed on non-commodity management goals such as aesthetics and wilderness, regardless of type or length of residence. While year-round residents place more importance on commodity management goals (timber and hunting) than seasonal residents, the views of new year-round residents are similar to those of seasonal residents. This could signal a shift in landowner views of public land management, with the importance of managing for timber and hunting declining over time as the population of the Pine Barrens continues to change.

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Notes

Elk Restoration in the Lake Huron - North Shore: Opportunities and Challenges

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Overview of Elk Restoration Efforts

Forty -seven radio-collared elk were released in the Nouvel township area of the North Shore in April 2001. The objectives of the release were:

- To increase the, biodiversity of the Lake Huron- north Shore landscape
- To increase ecotourism values in the area
- To increase educational /research values of a restored large mammal population
- To provide non-consumptive recreational values such as elk viewing and photo opportunities
- To provide an opportunity for recreational hunts should a sustainable population be achieved

The elk have been monitored weekly or bi-weekly from ground and as required from air by volunteers from the restoration committee and wildlife students from Sault College. To inform the public of elk movement since their release, dispersal and range maps have been distributed throughout the communities where the elk occur.

Biologically the elk have done well in their new habitat:

Recruitment:

- A minimum of 8 calves were born and survived the winter of 2001-02 (based on aerial calf survey, March 2002)
- A minimum of 10 calves were born and at least 8 survived the winter of 2002 -03 (based on aerial calf survey, April 2003)

Mortality:

- Two adults and possibly an uncollared calf were poached 2001
- One adult was shot by a hunter in error 2001
- One adult died in vehicle collision in 2002
- One adult was killed by a bear in 2001
- Three - undetermined cause 2001 -2002

Minimum population estimated at 50 to 55 animals in March 2003:

- 36 of original animals
- 7 to 8 yearlings (born in Ontario 2001)
- 8 calves (born in Ontario 2002)

Project Supporters

The project received support from a variety of organizations and volunteers (listed below). Thousands of hours of volunteer time have been expended in the many facets of this project.

- The Local Implementation Committee, a group of 75 to 80 volunteers, assisted with planning for the release, site selection, habitat appraisals, pen construction, pen security, post-release monitoring, and nuisance mitigation
- Local tourism industry
- Sault College
- Yamaha Canada
- Great Lakes Power
- St. Mary's Pulp and Paper, Clergue Forest Management, Algoma Forest Coalition, Meakin Forest Products
- North Shore Forest Coalition and members of the forest industry

Buse, L.J. and A.H. Perera (comp.). 2003. Meeting emerging ecological, economic, and social challenges in the Great Lakes region: Popular summaries. Ont. Min. Nat. Resour, Ont. For. Res. Inst., Sault Ste. Marie, ON. For. Res. Inf. Pap. No. 155.

- Hunters, trappers, and anglers groups
- Upper Lakes Environmental Research Network (ULERN); Canada Foundation for Innovation (CFI), OFI

Values derived from the project to date:

- Ecotourism from local tourism operators
- Elk viewing, photography day trips
- Educational/ scientific values
- Research projects

Challenges:

There have been some challenges, for example, with landowners concerned about elk damaging their crops. A brief summary follows:

- Beginning in late summer and fall 2001, up to 15 elk were attracted to and began to congregate in Kynoch Valley, especially in one farm field where fences were marginal
- Winter of 2001-02 elk were occasionally seen near stored hay. One incident of 2 cows and 2 calves in Desbarats area stored haylage was dealt with successfully.
- Spring-summer 2002 elk began to frequent same field in Kynoch. Deterrence attempts met with little success because of fence quality.
- Fall 2002, OMNR and the Implementation Committee provided financing for and, with volunteer assistance, erected demonstration fencing of 4 different types around three sides of the problem field to assess effectiveness for excluding elk. This is yet to be tested completely.
- Winter 2002-03, there were several reports of elk damage in farms adjacent to the fenced field; animals were reported damaging haylage bales and stored dry hay.
- Aversion techniques were applied somewhat haphazardly with limited success.
- February-March 2003, OMNR decided to remove some of the nuisance elk; 1 cow and 3 calves trapped, immobilized, and transported to Sudbury, Ontario.
- Reports of damage persisted until spring break-up

Problem Elk Mitigation Techniques and Challenges

Some of the questions and concerns that have arisen include:

- Who is responsible for the elk? Under what legislative authority?
- How is the extent of elk damage assessed and by whom?
- What techniques are available for their control and in what sequence are they used — the theory and the political reality
- Cultural aversion
- Exclusion techniques
- Harassment techniques
- Chases and drives
- Aversion by scare devices
- Rubber buckshot and bullets
- Dogs
- Chemical repellants
- Passive aversion
- Lure crops and intercept feeding
- Last resort measures
- Capture and transfer
- Destruction

Part of this presentation will include a discussion of mitigation techniques that have been attempted locally, and measures of success (or lack thereof), as well as the future of elk in the area.

Forest Certification of Private Forest Lands in Eastern Ontario

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Introduction

As one of 11 large-scale working model forests, representing one of the five major ecoregions of Canada, the Eastern Ontario Model Forest works with government, forest owners, industry, First Nations, and other stakeholders to develop sound methods to manage and sustain the forest resources of eastern Ontario and transfer our knowledge beyond our boundaries. During the summer of 2000, several large retailers publicly stated their intent to sell wood and wood products from "well-managed" forests. These announcements, coupled with expressions of interest in forest certification by many Eastern Ontario Model Forest (EOMF) members and partners, resulted in forest certification emerging as a topic of interest and discussion in eastern Ontario.

Forest certification is a process designed to encourage the sustainable management of forests by ensuring that forest owners, practitioners, and operators comply with established forestry standards. Independent third-party auditors evaluate forest operations to determine whether their owners meet the required standards; if they do, they may have their woodlots certified as "well-managed". Certification provides assurance to both the woodlot owners and consumers of wood products that the method and means of harvest does not damage the overall health of the forest or the stability and livelihoods of local communities. By buying forest products from a certified woodlot, consumers can support good forest stewardship practices.

In eastern Ontario, private landowners are stewards of more than three-quarters of the land, 34% of which is forest. Most of the stands are small and fragmented, since they are located in a densely populated region with many roads, waterways, farms, and residential developments. Though many yield wood products and sustain a variety of wildlife, their owners face several challenges, most notably how to properly manage their woodlots for all forest values and market their wood. The Eastern Ontario Model Forest and the Forest Stewardship Council (FSC) have undertaken a pilot project to assess the feasibility of FSC forest certification for owners of small, private woodlots in eastern Ontario.

The Approach

Several third-party certification systems exist in Canada, including the Forest Stewardship Council (FSC) certification program, the Canadian Standards Association's Sustainable Forest Management System (CSA-SFM) and the Sustainable Forestry Initiative. Following a comprehensive review of these certification schemes, it appeared that the FSC system had the greatest compatibility in an eastern Ontario context – where many small, private land holdings characterize the landscape. Also, the Forest Stewardship Council already had draft standards in place for the Great Lakes-St. Lawrence forest region.

Early in the project, it became evident that a broad-based working group would be needed to oversee activities, and provide critical advice and guidance to the process. Out of this, the EOMF Certification Working Group (CWG) was created, with representation from landowners, the Ontario Ministry of Natural Resources, the Ontario Woodlot Association, the Canadian Forest Service, Domtar – Cornwall, members of the EOMF board of directors and the FSC. There is also a representative from the Eastern Ontario Certified Forest Owners (EOCFO). Membership in the CWG is open to any individual or group willing to contribute time, expertise or resources to aid in the development of the certification initiative. The CWG acts as

Buse, L.J. and A.H. Perera (comp.). 2003. Meeting emerging ecological, economic, and social challenges in the Great Lakes region: Popular summaries. Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. For. Res. Inf. Pap. No. 155.

an umbrella organization that develops and manages the project. The CWG manages the content of the Eastern Ontario Model Forest Policies and Procedures Manual. The purpose of the Policies and Procedures Manual is to gather and share the information necessary to implement a Forest Stewardship Council forest management certificate.

Results and Discussion

As the forest certification project gained further momentum, the need for a conduit between the CWG and interested landowner participants also became evident. The EOMF, with the support of the Richard Ivey Foundation, was able to provide a project coordinator to address this critical need. With direction provided by the CWG, the project coordinator has worked closely with a group of 23 landowners representing over 10,000 acres in the Lanark area, along with members of the Domtar (Cornwall) private woodlot program, to obtain FSC certification.

Following an intensive 24-month period of project activity, the landowner group has been successful in obtaining SmartWood Resource Manager Certification - *SW-FM/COC 232* in accordance with the Principles and Criteria of the Forest Stewardship Council. The EOMF, through the CWG, will have the ultimate responsibility for managing the certificate and ensuring that forest operations meet those specified in the Great Lakes-St. Lawrence forest region Draft Standards.

Figure 1. *Eastern Ontario Model Forest forest certification target area.*

Formal partnerships with local sawmills have been created using a Memorandum of Understanding with the Eastern Ontario Model Forest. Local industry has agreed to pay operating fees for material originating from FSC certified forest under this project. This fee will be divided equally between the forest owner and the Eastern Ontario Model Forest. The forest owner will use their portion of the fee to offset operating fees for services provided, such as tree marking and harvest monitoring. Local industry has agreed to pay this operating fee over and above the procurement price because it enhances their chances of the raw material being saleable.

The Eastern Ontario Model Forest will use its portion of the fees to continue to provide administrative support to the forest owners. Partnerships with the local industry along with the competitive tender process offers forest owners fair market value for their timber.

The forest owners have created a formal group. This group is the Eastern Ontario Certified Forest Owners. This group is governed by an eight-member board of directors. The board has approved a constitution and has adopted a mission statement focusing on forest ecosystem education and the promotion of FSC certified forests in eastern Ontario.

For the immediate future, the focus of this pilot project will be to increase the number of participating landowners. The expansion and creation of new nodes for FSC certification, both within and beyond the EOMF, will also be an area of emphasis. There may also be an opportunity for the EOMF Certification Working Group to investigate the feasibility of different certification schemes for eastern Ontario.

Conclusion

While certification continues to grow internationally, on a local level, the EOMF has initiated a project that holds the promise of

significantly shaping the way that private forest holdings are viewed and managed. While forest certification is not the end in itself, it could be an important means towards the end goal of achieving sustainable forestry on the ground.

The results of this project – the first of its kind in Canada – will be transferred to other interested individuals and groups both within and beyond eastern Ontario. Already there has been a considerable exchange of information and experiences with others pursuing certification in Canada and the U.S.

Notes

Addressing Resource Sustainability and Market Uncertainty through Business Diversification: A Case for Bio-products and Non-timber Forest Products

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Introduction

Achieving resource sustainability, which is the mandate of governments and good business for the forest industry, can be accommodated by diversifying forest resource utilization through creative use of the forest resource. Two emerging innovations in the forest sector, non-timber forest products (NTFP) and bio-products, provide subsistence to full income opportunities for community entrepreneurs, and can diversify industrial options that help mitigate market uncertainties for companies.

The possibilities for creating business opportunities involving non-timber forest products and bio-products for northern rural communities in Ontario is significant. However, in Ontario the scientific information and institutional structure necessary to help ensure an effective, efficient, and equitable approach to a successful business environment for NTFPs and bio-product opportunities needs to be developed. The NTFP/Bio-product project seeks to address those critical elements which provide a foundation upon which a more comprehensive research strategy can be designed to support long-term business opportunities for people, communities, and companies in northern Ontario. Figure 1 provides the framework for the project, identifying the focus for each sub-project, the stakeholders who can benefit from the information and tools developed, and longer-term plan to employ research and development in helping support business opportunities. An NTFP business model into which the information and tools from research can be directed to help advance knowledge and performance of management systems for sustainable use (collection/propagation, processing and manufacturing, marketing and sales, and business incubation and aftercare) does exist in Canada and could be franchised. For the forest bio-products industry there are many examples of companies that have linked satellite industries to their core plant and are creating by-products with multiple values for an array of customers.

This project focuses on the use of forest resources as a source of products and services for key economic sectors, e.g., health, energy, environment, materials manufacturing, food, etc., and seeks to use the enabling technologies being developed as part of the bio-economy to address issues and opportunities associated with 3 key focus areas: global climate change, forest health and productivity, and rural economic development.

Project Approach

An approach to assess the social, economic, and ecological implications of diversifying product utilization as part of the enhanced forest management (EFM) cycle would identify opportunities to help northern rural forest communities work with local forest companies to develop diversification strategies. The approach has 5 objectives designed to set the stage for more comprehensive analyses:

(1) to develop an economic model to assess risks associated with entering into business ventures designed to commercialize NTFP and bio-products opportunities,

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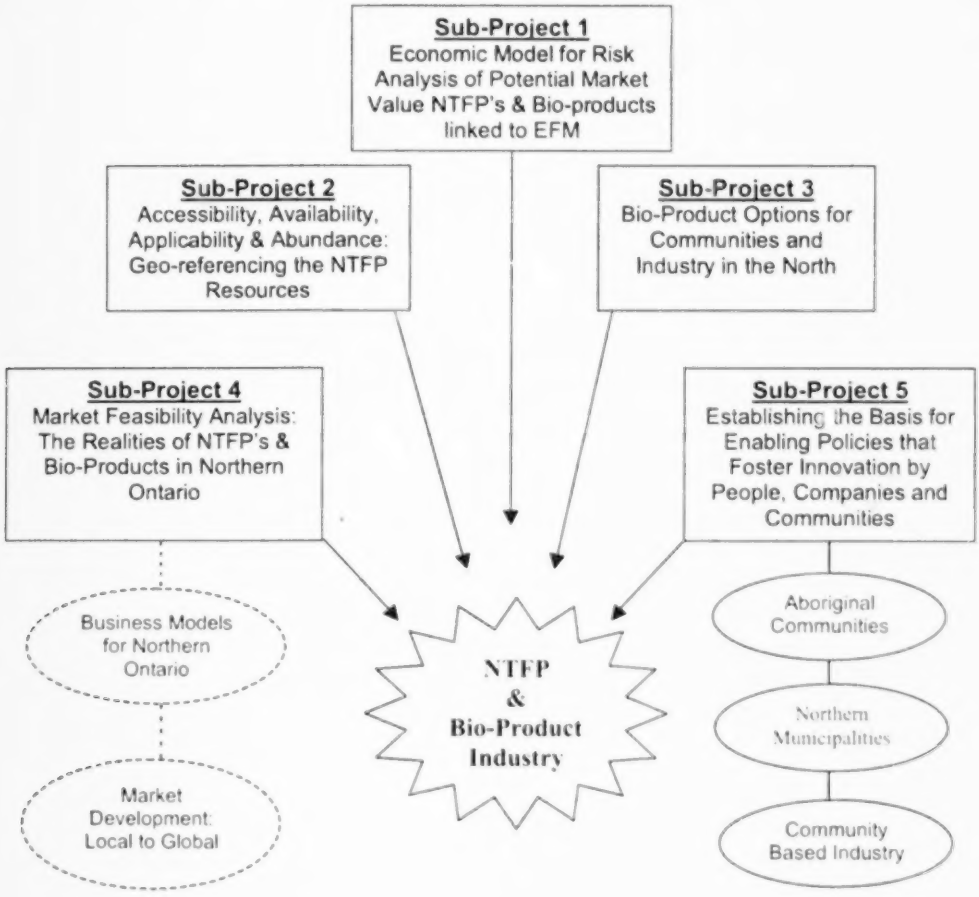
Sub-Project 1
Economic Model for Risk Analysis of Potential Market Value NTFP's & Bio-products linked to EFM
Sub-Project 2
Accessibility, Availability, Applicability & Abundance: Geo-referencing the NTFP Resources
Sub-Project 3
Bio-Product Options for Communities and Industry in the North
Sub-Project 4
Market Feasibility Analysis: The Realities of NTFP's & Bio-Products in Northern Ontario
Sub-Project 5
Establishing the Basis for Enabling Policies that Foster Innovation by People, Companies and Communities
Business Models for Northern Ontario
Market Development: Local to Global
NTFP & Bio-Product Industry
Aboriginal Communities
Northern Municipalities
Community Based Industry

Figure 1. *Socioeconomic opportunities for the forest-based communities: Non-timber forest products and bio-products.*

(2) to prepare a "state-of-the-art" review of forest-based renewable resource (bio-product/NTFP) options capable of creating socioeconomic benefit through forest sector diversification,

(3) to integrate scientific and traditional knowledge on the type and abundance of forest plants with associated NTFP/bio-product uses, and use a geo-referenced database to locate NTFPs by forest type,

(4) to develop methods and protocols for market feasibility analysis of NTFPs in pilot areas, and

(5) to identify policy and institutional implications of economic development of NTFP and bio-product opportunities for aboriginal communities and rural municipalities and recommend alternatives for creative, enabling policy development.

Implications to Communities, Companies, and People in the Rural North

The thread that links the 3 key focus areas is a function of, but not limited to: (a) the development of enabling technologies associated with the emerging bio-economy, (b) the influence of the "boomer" generation in affecting critical economic trend sectors, and (c) uncertainties in,

and concern for, the planetary, environmental, and human systems, particularly as it relates to climate change.

Global Climate Change – The Planetary System

The recent compendium report by the Union of Concerned Scientists paints a disconcerting picture of life within the predicted range of global warming scenarios for the Great Lakes region, and other regions in North America (Moser 2003). The implications to the environment and health, particularly in the context of resource sustainability are disturbing. However, forest ecosystems provide an abundance of renewable resources, which can be used to help mitigate negative impacts associated with climate change. This resource is virtually untapped in Ontario. This project will identify options for use of renewable forest resources to address concerns associated with global warming while creating opportunities for economic growth.

Forest Health and Productivity – The Environmental System

Forest-based activities in Ontario are governed by the Crown Forest Sustainability Act. The Act accounts for the development and use of non-timber forest products as a means of providing full value of the forests to the people of Ontario. Non-timber forest product values in Ontario's forests are categorized into 6 major product types: decorative and aesthetic products, landscape and garden products, food products, health and personal care products, materials and manufacturing products, environment and energy products. The market value derived from products within each category ranges from subsistence income to major industries. It is important to the sustainable availability of these products that policies enable economic growth while protecting the integrity of the resource. This project will provide specific information about forest species (from lichen to trees), where they are located, their relative abundance by forest type, and their known uses by non-timber category. The increased focus on these species, many of which are sensitive indicators of ecosystem stress, will enable more intensive monitoring and assessment of forest-based activities, allowing for more reliable and timely interpretation of risks to the resource.

Rural Economic Development – The Human System

The rural areas of Ontario, particularly in the north, tend to be one or two industry towns. Developmental possibilities associated with the non-timber forest products industry could diversify local industry and greatly enhance economic growth by addressing the needs and interests of key economic trend sectors; particularly health, energy, environment, materials manufacturing and/or tourism/eco-tourism. This project will identify NTFP and bio-product opportunities that have positive socioeconomic benefits for communities, companies, and people and will review current policy and institutional structures with the intent to optimize the latitude and flexibility needed to provide meaningful options for economic development.

Benefits

The products and services derived from forest sector diversification would target key economic trend sectors. This approach advocates a move to the bio-economy, similar to what has been accomplished in the agricultural sector with their transition away from a commodity-based to a value-added industry. Because it would rely on more effective and efficient use of renewable resources for a broader array of products and services that generate wealth from the forest, it could reduce reliance on traditional resource extraction. Thus, it has the potential to support sustainability strategies while mitigating the effects of global warming.

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Notes

Wisconsin's Master Woodland Steward Program: Teaching Sustainability and Reaching Out to Others

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Introduction

Wisconsin's Master Woodland Stewards program offers intensive training for woodland owners who are interested in learning more about sustainable forest management practices and becoming better stewards of their land. The Master Woodland Steward Program is designed to provide instruction to non-industrial private forest landowners on the basics of sustainable forest management and to gain an understanding of the social, economic, and ecologic value of forestland to the state of Wisconsin. The Program also provides instruction on community outreach techniques and requires graduates to create an action plan to help them use the knowledge they gain to address real issues in your community. One of the major benefits of the Program is that it provides participants with the opportunity to meet other woodland owners and share ideas and information about management strategies in a fun and educational setting. Through this process the program equips the graduates to work in their community as a model and resource for the sustainable management of forestlands.

Approach

The Master Woodland Steward Program is designed to take advantage of peer - to - peer networks that forest landowners develop in their community and through involvement in woodland owner organizations. By providing information and education on sustainable forest management practices we hope to achieve a multiplier effect as Program graduates practice and work in their communities to promote sustainable forest management.

Participants in the Master Woodland Steward program receive more than 30 hours of instruction from University of Wisconsin, Department of Natural Resources specialists, and experts from industry and conservation organizations. The Program combines classroom instruction and outdoor experiences to teach participants the basics of stewardship, sustainability, and forest management planning, forest ecology and silviculture, forest management techniques, forest management business decision and planning tools, and community outreach techniques. Participants also receive reference materials in each subject area to aid their retention and provide a resource as they reach out to other forest landowners.

As a part of the course, graduates are required to develop an Action Plan. The purpose of the Action Plan is to help the graduate use the knowledge that they gain through participation in the Program and use it to address real issues in their community. The Action Plan serves two purposes. It helps participants think about how they will use what they learn beyond the management of their own lands and it provides a sense of camaraderie and shared purpose as they help each other think through and develop their plans.

Working with University of Wisconsin Extension's Environmental Resources Center we developed a methodology to measure the impact of the program on participant's application of what they have learned and their impact on their community. Specifically, we want to understand the impact of the program and assess the changes in participant knowledge and behaviours, the extent to which participants are

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interacting with others regarding forestry issues, and the effects of participant interactions with their neighbours and community. Our assessment strategy involves a four-part data collection effort: 1) a pre-course questionnaire that measures baseline levels of knowledge and outreach activity (collected as part of an application or registration process); 2) a series of "Session Feedback" forms that participants will complete following each course module; 3) a summary or exit evaluation conducted at the end of the eight-part course; and 4) a follow-up contact with participants approximately a year after they have completed the course.

Results

The Master Woodland Steward Program was piloted in 2002 with sessions held in Rhineland and Hayward, Wisconsin, in September and October. To date we have collected and analyzed the data from the pre- and post-surveys. The one-year follow-up surveys will be completed in the fall of 2003. The baseline inventory of program participant's knowledge was highly variable. Some felt they were very knowledgeable and had years of practical hands-on experience in the management of their woodlands while others felt they were novices. Results from the summary survey showed that each participant felt their level of knowledge had increased. The overall average increase between the pre- and post-surveys was 21 points (see Table 1).

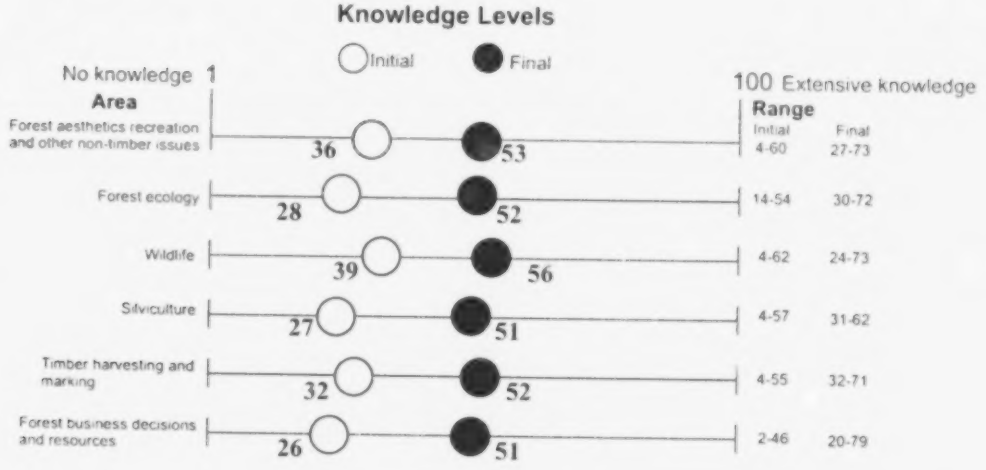
Overall, graduates were pleased with the program and the experiences and information that were presented. About 90% of respondents felt that the Master Woodland Stewards Program exceeded their expectations. Also, a comparison of the per session evaluations and post-session surveys showed that requests for additional information tended to match the presentations that were most popular with the participants.

Initially 71% of respondents were "interested" to "very interested" in providing neighbours and other community members with advice or information on forest stewardship. Upon course evaluation, all participants felt prepared to discuss program materials with members of the community. Additionally, by the end of the course all of the participants felt confident that they could refer a woodland owner to the appropriate professional for various types of forest management assistance.

Discussion

Based on the pre- and post-surveys and the session evaluations we know that program participants felt that they received valuable

Table1. *Current levels of knowledge associated with the following areas before (application/registration) and after (program course evaluation).*



information and that they would be able to incorporate it into the management of their lands. We also learned that their comfort level in presenting this information to their neighbours and peers had risen remarkably.

While each of the participants were very interested in the curriculum and what they would learn many were skeptical about working with their neighbours and were uncomfortable with developing an Action Plan. However, the program is designed to provide participants with the opportunity to share their ideas and receive feedback from each other. As noted in the results section, by the end of the program all of the graduates felt prepared to discuss what they had learned with their neighbours.

There are three common themes to the Action Plans that graduates have developed. Most graduates developed plans to provide their neighbours with information on financial and technical assistance programs. An outstanding example of this is a program graduate who mailed a copy of his management plan to all forest landowners in his township and invited them to visit his property or offered to visit them on their property to discuss forest management. The second common theme are graduates who plan to develop field days or walking tours of their properties for their local community. The third common theme is an interest in developing landowner workshops in partnership with University of Wisconsin Extension or other higher learning institutions to share what they have learned.

Conclusion

Wisconsin's Master Woodland Steward Program holds the promise of meeting its goals and creating a core group of forest landowners trained in the basic concepts of stewardship and sustainable forest management. These landowners are providing service to their communities using what they have learned through the development and implementation of their Action Plans. However, the success of the program will continue to be based on the efforts of the graduates as they implement their Action Plans and, through grassroots action in their local communities, encourage their neighbours and peers to think about the stewardship of their forestlands and the application of sustainable forest management practices.

Notes

Forest-Level Indicators of Socioeconomic Sustainability

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Demands for greater clarity with respect to sustainable forest management emerged in tandem with the paradigm's acceptance within the global forest constituency, a constituency comprised in large part by public agencies – governments, ENGOs and academic institutions[1]. The development of specific and accepted criteria and indicators became the mechanism by which sustainable forest management is given definition and through which its progress can be monitored and assessed. Subsequently a variety of regional, multilateral initiatives were launched to identify appropriate criteria and indicators. The variety of regional initiatives included the Pan-European, Montreal, Tarapoto, Dry-Zone Africa, Near East, Lepaterique, Dry-Zone Asia, International Tropical Timber Organization, and the African Timber Organization. Criteria and indicators were drilled down to national and sub-national geographies as these agencies attempted to link their activities to the international environment. More recently, attempts to initiate certification processes at the corporate level have led to the development of criteria and indicators at this relatively refined level of organization. Throughout these processes, the multi-dimensional nature of sustainability has been respected – although it may vary in detail, generally at least three dimensions (sometimes more) are identified – the environment/ecology dimension, the economic/industrial dimension, and the social/community dimension.

Most of the global forest estate is managed as a publicly owned resource, where the public forest resources are managed as individual forests. In these cases, public agencies have two very distinct roles. On the one hand, they are stewards of the public resource and all of the public values associated with it. On the other hand, they are managers of the public's timber assets and all of the financial implications associated with this role. The identification of criteria and indicators for the public agency's dual role in the management of public forests complicates the search for appropriate measures.

This is certainly the case in Province of Ontario. The Ontario Ministry of Natural Resources (MNR) manages a vast forest estate owned by the provincial Crown. It encompasses 33 million hectares structured into approximately 50 forest management units. Strategic direction for management of this vast estate is derived from the *Crown Forest Sustainability Act* (1994) and its regulations, including the *Forest Management Planning Manual* (1996). Management for a balance among the three pillars of sustainability – environmental, social, and economic – is a core strategic value.

At the broader provincial level, the MNR has adopted a top-down approach. Ontario criteria for forest sustainability are consistent with those articulated in the Montreal Process. There has been more latitude in the development of specific indicators and their metrics. The Ontario interpretation of these indicators and their metrics is published in the *State of the Forests Report, 2001*.

Planning at the forest management unit level is led at that level through a process specified in the Forest Management Planning Manual. It is a bottom-up process, with considerable leadership from local agents – Sustainable Forest License holders, local communities, and other interest groups.

[1] There is no intention here to degrade the role of the private, for-profit sector.

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This paper examines issues associated with the development of appropriate forest-level indicators of socioeconomic sustainability. A number of candidate indicators have been proposed. They have proven wanting in that they relate to measures beyond the scope of the forest manager. They would focus on the socioeconomic impacts associated with the wood flow including jobs, incomes, and green GDP. These are all appropriate indicators from the perspective of the MNR as an agent of the Government of Ontario. However there is need for an indicator that is more reflective of the socioeconomy associated with the timber flow off the forests within the forest management unit. By default, the volume of timber harvested, bounded by the allowable harvest, has become the local level indicator of economic sustainability.

There are advantages and disadvantages to using this indicator at the forest level. The author reviews these strengths and weaknesses and proposes a modification to this metric.

Notes

Integrating Social, Economic and Environmental Priorities to Achieve Sustainable Development

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The need for social and economic improvement in rural areas is very real and becoming increasingly important as traditional resources-based industries face increasing competition. An emerging question in natural resource policy is how to foster rural area and community social and economic well-being while at the same time improving and protecting the natural resource base. Traditionally, economic, social, and natural resources issues have been treated separately – planned for separately, addressed separately, and acted on separately as if there were no relationship among them. If we are to improve social and economic advancement in rural areas, we must rethink the relationship between social, economic, and natural resources priorities and which are objectives and which are constraints. Too often natural resource and environmental priorities predominate as objectives in rural areas when, in fact, they should often be viewed as constraints within the system.

Establishing Goals and Objectives

Rural and urban landscapes are combinations of many elements including social, economic, and natural resource elements, none of which are mutually exclusive. There are complex inter-relationships among all these elements that must be recognized in any effort to promote sustainable development, both spatially and temporally. Current reality establishes the baseline from which to start sustainable development planning efforts, with history defining past experiences and future scenarios defining what may be possible within various goals and objectives.

Traditional planning in urban and suburban landscapes accepts the premise that communities and economies will grow. Attention within such efforts is often focused on goals and objectives to guide the form and manner of that growth to maintain high quality of life within cities and suburbs and stable or growing economic structures. Environmental and natural resources within these environs are constraints on the system – availability of land, availability of water and wastewater treatment systems, availability of open space – that planning and growth management policies seek to minimize. A definition of sustainable development in an urban setting might be development which maximizes community and economic well-being while minimizing impacts on environmental and natural resource systems to the extent possible. The primary focus, however, is clear.

Why should traditional planning and sustainable development in rural landscapes be any different? Traditional planning in rural landscapes is often focused on goals and objectives based on preservation or change of environmental and natural systems whether or not such goals are desirable or achievable given rural community or economic systems. In many cases, community and economic systems are presented as constraints or unimportant in achieving some natural resource agency's or organization's environmental ideal. This is exactly backwards.

An outrageous example of the arrogance of this orientation appeared in the Minneapolis Star Tribune in 1998. A company had proposed a peat harvesting operation near Big Falls Minnesota. The mine would have created 30 jobs in Big Falls (an area in desperate need of jobs and economic development with a population around 1,000) for 30 or 40 years and involve the harvest of 800 acres of sphagnum

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bog. This proposal occurred within the following context – Minnesota has 7.5 million acres (3 million ha) of peat, 130,000 of which is high quality sphagnum; 100,000 of this is protected leaving 30,000 for potential harvest of which only 1,000 are currently being harvested using systems that allow for its regeneration. Given these circumstances it was beyond belief that someone from the MN Department of Natural Resources was quoted as saying that "The DNR put the economic development needs of one region ahead of the state's need to preserve a unique oasis from development for all residents."

The project was eventually denied the permits required for its operation. This lack of balance in addressing social, economic, and environmental concerns is appalling and is a major obstacle in achieving sustainable development based on natural resources.

Despite popular rhetoric, nature is not fragile; it is human society that is fragile and we as a society project our fragility upon nature. The Bruntland Commission defined sustainable development as providing for the needs of the present without diminishing prospects for future generations. Equity among human generations is stressed. Natural resource planning and policies in rural areas, at least in the U.S., have not met this test.

More enlightened thinkers in the natural resource field are starting to understand that initiatives without social and economic goals do not meet this definition of sustainability. Establishing national parks in South America when residents adjacent to the park cannot benefit economically or materially is not sustainable. Limiting timber harvest on western U.S. forests, which results in severe economic collapse in forest-dependent communities, elimination of the opportunity for offspring to earn a living within the forest products industry, and catastrophic wildfires, is not sustainable.

Delaying construction of the McKenzie Valley pipeline to carry natural gas from the McKenzie Valley in the Northwest Territories to U.S. markets until local Aboriginal social institutions and structures were strengthened enough to sustain the influx of non-Aboriginal construction and pipeline workers was sustainable. Social goals and concern for community values and structure were preeminent in this decision and I suggest that this should always be the case and should be applied more widely and consistently in sustainable development and planning in rural areas.

Lessons From an Unintended Experiment

In 2000, I served as staff on a landscape-level planning project for an ecological region called the Northwest Sands area in Wisconsin. Landscape-level planning is being advanced in the U.S. as a means of improving coordination among landowners in advancing towards a common set of generalized goals. For the most part, these efforts have failed primarily as a result of exclusive focus on environmental resources and "issues" as opposed to "opportunities". In an attempt to overcome this dismal track record, the Northwest Sands planning effort relied on several unique approaches, the most central of which was equal consideration of social, economic, and natural resource elements of the landscape.

Social data and the weaknesses/opportunities they presented were examined first. These included resident demographics, housing characteristics, seasonal resident influences and local government capacity. Social systems define limits and opportunities to address the economic structure of areas and boundaries within which decisions on the use and management of natural resources are made.

Economic data and the weaknesses/opportunities they presented were examined second. These included economic structure, forest-based recreation, forest products and agriculture, and wildlife-based economic activity. The ability to earn a living and support a family is a necessary underpinning to a stable social structure. The existing structure of an economy offers a starting point from which to focus future development.

Environmental/natural resource data and the weaknesses/opportunities they presented were examined third. These included geologic and climate characteristics, ownership characteristics, forest resources, disturbance history, habitat types, water resources and wildlife resources. In a predominately rural, natural resource-based economy, the resources of the area are the building blocks of both social communities and economies and a defining characteristic of rural landscapes.

This sequence of considerations – social, economic and environmental/natural resources – had a very interesting and positive effect. Discussion and goal and strategy development centered on how to effectively manage resources and create policies to address social and economic needs and problems, as well as, policies related to natural resource management in light of social and economic trends. Social and economic considerations were correctly viewed as the drivers of forces affecting sustainable development and the challenge became how best to manage resources within this human-defined environment and context.

For example, the ecologists of the group identified restoration of oak and pine savanna as a high environmental priority within this particular landscape since this cover type had been considerably reduced over time. This idealized goal soon gave way to strategies grounded in reality when it was recognized that the physical location of the best restoration sites were on private land where reforestation programs discouraged the creation of this type of habitat; where there was strong growth of vacation homes that parcelized the forest and made the use of fire (the most common disturbance occurrence in this type of habitat) nearly impossible; and that on the most suitable public lands large-scale planned disturbance by fire or extensive clearcuts was politically unacceptable.

Conclusions

To achieve sustainable development, such development must be accomplished within human-centred and defined systems. Most rural planning and development activities related to natural resources focus on maintaining or changing ecological systems independent of the community and economic systems dependant on them or from which a major part of their identity is derived. To achieve sustainable development, this situation has to change. The goals and objectives of social and economic systems must be defined first since they are the drivers affecting natural resource condition and use. Greater balance must be established between social, economic, and natural resource consideration in making rural development and management decisions, at least in the U.S. From my perspective, Canadians seem to have done a better job at achieving this balance.

Notes

Resource Stewardship Agreements : Addressing the Needs of Ontario's Resource-based Tourist Industry in Forest Management through Cooperative Planning

Stephen Harvey

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Ontario's forest managers continue to search for new ways to solve planning problems. One strategy is to have those most affected by a plan participate in developing "planning solutions." Engaging the "stakeholder" through a variety of measures is now commonplace in the world of forest planning. Ontario has recently formalized a process of collaborative planning for two key stakeholders: the forest industry and the resource-based tourist industry (lodges). An examination of the process for bringing these often-divergent interests together may be instructive for others who are struggling with planning conflicts. The process outcome, termed Resource Stewardship Agreements (RSAs), offers many benefits to the participants; however, the potential they bring by reducing conflict is not unlimited. RSAs should be regarded as one of many planning tools available to support the development of an effective forest management plan.

Forest management plans must be prepared before any commercial forestry operation can occur on public forest lands in Ontario. The ultimate goal of the plan is to provide for the long-term health of the forest while enabling current and future generations to meet their material and social needs. The forest management plan considers the needs of a variety of forest interests and provides for them while protecting the integrity of the forest ecosystem. The challenges of sustaining the interests of a diverse group of forest users are many. The forest industry needs to control wood costs and supplies. The tourist industry sells the natural beauty of the forest including scenic vistas, peace and quiet, and the perception of wilderness. In some cases satisfying both these needs through the planning of access, harvest, and renewal activities seems impossible. However, considerable common ground is revealed when a process is put in place that allows both parties to disclose site-specific interests to each other and then sees them jointly craft solutions that will address these interests. This interest-based, collaborative planning by the resource-based tourism and forest industries is the essence of the RSA process.

The RSA process is quite simple and follows the tenets of good planning:

1. plan ahead (start early)
2. identify the players
3. understand each other
4. define your interests
5. work cooperatively to develop planning solutions that address your interests
6. steer the plan input through the planning process
7. monitor the implementation of your planning solution
8. honour your commitment by making in-plan adjustments where necessary to address the objective of your planning solution, and
9. maintain the relationship with your planning partner

In practical terms, good forest planning can accommodate harvesting operations in areas used to support tourism. RSAs can be effective when they develop planning solutions for roads close to lodges, or for harvest operations that may be seen across the lake from a lodge. They may make use of space and time to separate the two

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business operations, or they may result in modifications to normal operations. Operations may be modified through a partial harvest system or the use of no harvest reserves. This ensures that forest industry gets the required wood at a reasonable cost and the tourist industry can continue to operate its business in the forest.

Planning solutions resulting from RSAs can be effective when the solution does not impinge on any public interest, i.e., it deals with a small part of the forest in which only the two parties have expressed a specific interest. RSAs can also be effective when the two parties have sufficient understanding of the public interest and are prepared to address it in their planning proposal. However, the potential for an RSA to result in effective planning solutions is reduced when these two industries must address the interests of other users.

Ontario's forest management planning policy directs planners to seek broad public involvement in the development and review of plans. This is required because, in many cases, the public interest in the forest is only understood in a general sense until a planner initiates the development of a plan for a particular area. This general understanding is reflected in the land use direction. For much of the public forest in Ontario the land use category is "general" and "broad" in scope and intended to permit a variety of uses, many of which will be in conflict with the resource-based tourist industry at the local or site-specific level.

RSAs are a good example of interest-based collaborative planning and they can be invaluable as a means of developing planning solutions. However, solutions offered by RSAs can fail if the public interest is not addressed. Knowledge of the public interest may come from detailed local policy. When such policy is lacking there are ways to better define the public interest but, as most public forest managers know, these require time, effort, and commitment to work. Any planning solution developed in isolation of the public interest runs the very real risk that it will fail, fail to be accepted during review or fail during implementation.

Managers of public forests must assess the benefits of collaborative planning by stakeholders. While they cannot presuppose the outcome of such planning, they can assist the parties by scoping the planning effort with those who have expressed an interest in collaborating. Such scoping must consider the extent of the public interest, how well the public interest is understood, and the willingness of parties to address it in a planning solution. With a fuller understanding of the public interest, stakeholders engaged in interest-based planning can collaborate to develop effective planning solutions as evidenced by Ontario's Resource Stewardship Agreements.

Public forest policymakers will be challenged in the coming years to craft policy that provides clear direction to stakeholders who wish to collaborate in the development of forest planning solutions.

Global Community-Based Sustainable Forest Indicators Partnership

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Introduction

The purpose of the Community Indicators for Sustainable Forest Management Partnership is to help local people achieve community well-being within the context of a sustainably managed forested environment. The partnership, being pursued in association with a global caucus or movement for community management of natural resources organized in conjunction with the World Summit on Sustainable Development (WSSD), seeks to engage communities around the world. Specifically, the partnership will:

- Link communities and technical support partners to design a framework for cross-community and cross-cultural learning
- Exchange strategies for and information about, for example, community capacity-building processes, indicator development, data collection, citizen monitoring, and policy and practice implications
- Study, report, and disseminate successful strategies, lessons learned, and emerging challenges
- Seek to link and influence local-to-global sustainable forest and sustainable community strategies

Resources: Since being launched at the WSSD, a variety of resources from public and private sources are being sought. The U.S. Government's commitment to date is $50,000 and the Canadian Forest Service Model Forest Program has also committed their support.

Partners: This partnership was initiated by and continues to be led by a non-governmental organization, the Great Lakes Forest Alliance, Inc. The Alliance (www.lsfa.org) has been working on behalf of the Communities Committee of the Seventh American Forest Congress to recruit partners within the United States as well as elsewhere in the world through the Community Based Forest Management Global Caucus. Current partners include:

Civil Society: The Great Lakes Forest Alliance, Inc.; The Communities Committee; The Lake Abitibi Model Forest Program, Ontario, Canada; Gogebic County Forest Advisory Committee, Michigan; Joint Energy and Environment Projects, Uganda; African Research Association, Nigeria; Development Initiatives Network, Nigeria; Foundation for Ecological Security, India; EC INCO DEV, Uganda; Community Development Study Center, China; and Regional Community Forestry Training Center for Asia and Pacific, Thailand.

Governments: United States (Department of Agriculture) and Canada (Forest Service)

Approach

In the United States, the partnership builds on indicator and monitoring work of the Communities Committee as well as criteria and indicators efforts underway by the multi-stakeholder Roundtable on Sustainable Forests. A domestic workshop will be held in April 2003 to gather input from diverse interests. Globally, the partnership supports the vision/objectives of the network of community organizations involved in the global caucus that continue to interact following meetings held in Bali, Indonesia, leading up to the WSSD and again in Johannesburg, South Africa, at the Summit. Caucus participants have developed a paper for the World Forestry Congress being held in Canada in September 2003, and plan to discuss partnership opportunities while there. Linkages also are being sought with other partnerships that include peer-to-peer learning as a strategy for sustainable management.

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The group seeks additional funding to support an array of education and exchange opportunities. For example, the group intends to stage monthly discussion topics, including, but not limited to: processes for developing indicators; monitoring sustainable environments with volunteers; local zoning or land use components; social values and indicators; ecological values and indicators; economic values and indicators; aggregating data from the local community to the national scale; and integrating measures across the sustainability sectors. Partners plan to provide opportunities for multi-national tours and visits among community members and provide scholarships for local leaders from all countries to visit at least one other community site. A community forestry professional would lead the visit to engage in dialogue and experiences that help local leaders develop strategies that will work most effectively at home.

The group also intends to study, report, and disseminate to other communities successful strategies, lessons learned, and emerging challenges. They will develop a participatory research protocol that engages community and researchers to develop ***Study Papers*** on key community indicator and monitoring topics that are raised by community participants and include community case studies, such as, but not limited to: influencing effective data collection for national social/economic indicators; participatory research; open and transparent processes; influencing public policy. Funding will be sought for Community Liaisons to work with individual communities and document community milestones in relation to defining indicators, collecting data, monitoring trends, and reporting results and collate these in a ***Community Indicator Case Study*** report. The group will document the successes of the community efforts at the next World Summit on Sustainable Development and the World Forestry Congress as well as through local, regional, national, and international journals and presentations, the United States Sustainable Forest Roundtable and other such groups. All findings will be posted to the Communities Committee website and printed documents will be made available at presentations.

Partners will seek to influence local to global sustainable forest/sustainable community strategies by conducting a symposium to showcase and exchange community experiences and support travel for one person from each country and help others obtain funding. The impacts on public policy, the cross-fertilization of ideas, the integration of indicators across social, ecological, and economic sectors, the influence on and adaptation of forest management, and the revisions in indicators will be monitored by Community Liaisons. They will document the impact of the community work on national data collection, policy development, and depth of implementation of forest management adaptations in ***Community Case Studies***.

Discussion and Challenges

The partnership seeks involvement of other local level groups who are engaged in community indicators for forest resources through an open and transparent process. The group is also interested in being made aware of emerging local level indicator efforts related to the forest resource and additional discussion topics that might be addressed.

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A Unique, Collaborative Approach to Biodiversity Training

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Introduction

Louisiana-Pacific Corporation (LP) wanted to provide a biodiversity training workshop for its foresters and wood procurement personnel in the Great Lakes Region. By collaborating with a number of unlikely partners, LP was able to provide a cost-effective training session that was deemed to be very informative and useful by many of the workshop participants.

A two-day workshop entitled *Biodiversity and Forest Management Opportunities* was held at the Fortune Lake Camp near Crystal Falls, Michigan in May 2002. The workshop was developed and presented by White Water Associates, Inc. (WWA), under contract with LP. A key objective of the session was to help LP's field personnel identify and properly deal with situations that might involve threatened or endangered species.

Workshop Content and Format

Dr. Elizabeth Rogers and Dr. Dean Premo of WWA conducted the workshop. Both have conducted forest management research, done professional consulting, and developed and conducted workshops on numerous ecological topics. They have also been involved with forestland audits (both SFI and Smartwood). Dr. Rogers is an ornithologist and expert mammal tracker. Dr. Premo is a herpetologist by training and knowledgeable aquatic ecologist.

The two-day workshop consisted of a classroom session (day 1) and a field trip (day 2). The classroom session combined a variety of traditional (lecture, slides, handouts) and non-traditional (team exercise in forest management) approaches to biodiversity and forest management training. The field trip included plant and animal identification conducted in a variety of aquatic settings (lake, vernal pool, and stream). Both the classroom and field trip sessions included extensive opportunities for questions and comments.

Workshop Feedback

Although there was no formal workshop evaluation, much of the anecdotal feedback has been very positive. Participants generally felt the workshop delivered a very practical approach to dealing with biodiversity that they would be able to make use of in their work. Some of the key messages that workshop participants found useful were:

- Riparian zones can be actively managed if proper care is taken
- Generally speaking, visual diversity = biological diversity
- Vernal pools are important to a wide variety of species

Conclusion

The *Biodiversity and Forest Management Opportunities* workshop provided a unique experience for LP's procurement foresters to receive training that was not readily available elsewhere. By including loggers, landowners, conservation organizations, and other industrial foresters, a variety of backgrounds and experience was included in the mix of participants. This blend of perspectives helped to stimulate discussion and allowed for more in-depth treatment of a variety of topics.

The inclusion of a broad base of participants also helped to reduce the unit cost for everyone who attended. Without the participation of these various "outsiders", it is very unlikely that LP would have been able to afford to provide the training to its people. Economics therefore played a key role in LP's decision to include a variety of non-LP personnel in the workshop.

Once it had been determined that LP would host a workshop with about 50% LP personnel and 50% non-LP personnel, the question that

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remained was, "Whom shall we invite?" Each resource manager in the North Central Region was asked to provide a short list of potential invitees. The final list of invitees was meant to provide a broad mix of interests and backgrounds. This consideration of social perspectives helped to provide an interesting and diverse assortment of workshop participants.

The authors hope that by sharing the positive experience of this particular workshop, others may follow with similar collaborative training efforts. Not only can economies of scale be achieved through such endeavours, but there are also opportunities for broader social acceptance of the value of the specific training, as well as of work done by forest resource professionals in general, through such collaboration.

Notes

The Commercial Forest Value Chain and the Socioeconomy

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Individual economic sectors differ in their inherent capacity to support socioeconomic growth and sustain their economic competitiveness. Technology-intensive activities tend to exhibit stronger growth characteristics, provide greater opportunities for exploring new prospects – on both the supply and the demand sides of the market – thereby sustaining productivity increases and stronger, more comprehensive linkages to the local, regional and national economies. In addition, they generate higher value added and impose higher barriers to entry to newcomers. Lower value-added sectors do indeed provide benefits to the socioeconomy and may be pivotal in support of higher value-added sectors.

The problem confronting firms, sectors, and socioeconomies specializing in the production of low value-added goods and services is that in highly competitive markets they will be increasingly subject to returns being eroded by falling terms of trade and the race to become the lowest cost producer. Understanding the value chain and its determinants can provide important insight towards the development of conditions to support regional economies through higher value economic sectors. They provide insights into the degree of development retained within the specific jurisdiction, areas of comparative advantage, and the institutional and policy challenges that will sustain incomes over time.

In its most comprehensive meaning, the value chain describes the full range of activities that are required to bring a product or service from conception to the final consumer. The value chain will encompass the full range of economic activities, from accessing the basic resources, the physical transformations and associated services required in producing, transporting and selling the product to the final consumer. It may also include final disposition of the physical product after use.

Before we describe the timber industry value chain, we note that value chains are spatial in nature. Accessing the natural resource may take place at one physical location, with transportation to the location of initial processing facility. The output of the initial processing may be transported to other processing facilities for further physical transformation before the product enters into the distribution system to reach the final consumer. Once used, additional links in the chain may be related to final disposition such as recycling and/or waste programs. Each of these activities may be crossing local, regional, and national boundaries. The governance chain through which an agent's activities are governed can become an important issue for understanding the efficacy of the chain.

Ontario's commercial timber sector combines forest management, logging, manufacturing, and services within and among regions. It generates incomes and employment linking resource-based communities with highly industrialized urban centres. The timber value chain extends the framework to encompass product distribution networks to the final consumer, and in many cases, recycling programs such as Ontario's Blue Box program. This paper will focus on the application of the value chain heuristic to the Ontario timber products industry.

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Biodiversity Indicators in Sustainable Forestry Programs

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Introduction

National- and international-level sustainable forestry processes such as the Montreal Process and certification programs such as Canada's National Sustainable Forest Management Standards and the Sustainable Forestry Initiative℠ (SFI) often contain criteria or indicators that address biological diversity and other fundamental ecosystem attributes. Yet, questions remain about the appropriateness of metrics related to biological diversity. We studied example sustainable forestry programs from Europe and North America to identify criteria and indicators related to biological diversity and ground-level metrics that are specified in the programs and being implemented by certifiers. Additionally, we reviewed the literature to identify wildlife and biodiversity metrics that have been recommended to measure the sustainability of a forest and its inhabitants.

Biodiversity Metrics in Certification Programs

We reviewed biodiversity-related metrics used by the SFI, American Tree Farm System, Forest Stewardship Council, Scientific Certification System, Smartwood, Green Tag Forestry, Pan European Forest Certification Council System, Finnish Standard, Canadian Council of Foreign Ministers, Swedish PEFCC, and United Kingdom Woodland Assurance Scheme. We identified two approaches used by the programs—one based on an organization's current management processes and the other based on actual measures of forest components against desired standards or outcomes. Examples of process-oriented metrics include whether landowners use professional expertise, agreements/relationships with agencies, or land classification or mapping system; or include biodiversity goals in harvest plans. Examples of stand-level outcome-oriented metrics include age, size, and species diversity of trees; amount of dead wood; or presence of mixed species stands. Landscape-level outcome-oriented metrics include variables such as maintenance of ecological function and productivity, adjacency of stand age classes, protection of forests with exceptional conservation value, and measures of fragmentation.

Biodiversity Metrics in the Scientific Literature

We reviewed more than 150 publications to assess the scientific validity of wildlife and biodiversity metrics that have been proposed in the literature. We identified a large number of suggestions for selecting biodiversity indicators/metrics. For example, authors have suggested that metrics should provide continuous assessment over a wide range of stress, be applicable over a broad geographic area, and should be easily identified and monitored. Authors have suggested using the following as metrics: species groups or guilds such as macrophytes, neotropical migratory birds, and plankton, and habitat features such as area of late-successional forest, biomass increment, canopy openness, patch density, and patch shape indices.

Overall, there appeared to be little objective research in the area of biological diversity and wildlife metrics, the existing studies were narrowly focused, and the indicators appear to

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have been subjectively chosen by the researchers. Identifying appropriate metrics is difficult in part because the vast literature related to metrics is based mostly on correlational data from studies of short duration (3 years or less), and generally do not allow cause-and-effect inference.

A Process for Developing and Using Biodiversity Indicators

Because of these considerations, we found no universally accepted or rigorously validated metrics for biodiversity. However, we identified several important concepts in the literature related to developing and using biodiversity metrics.

First, indicators should be selected only after the goals of biodiversity conservation efforts have been established. The indicators should address goals in a clear and measurable manner and be economically feasible to monitor. Furthermore, it is likely that multiple indicators (rather than a single indicator) will be required to address various aspects of biodiversity over appropriate temporal and spatial scales and to describe or measure progress toward achievement of goals.

Biodiversity goals are likely to vary among regions and interested stakeholders. Therefore, the scales at which to establish and achieve goals is a key consideration. We suggest that goals be established within regions but at multiple scales for varying landowner types and size of ownership. Goals also should not exclude one group of wildlife while focusing on the conservation of another.

Regional conservation strategies are needed before meaningful biodiversity goals can be defined at the landscape or ownership level. Regional strategies should be based on an inventory and assessment of protected species, declining species, species of economic or recreational importance, and other important species. Existing regional and national conservation strategies such as Partners in Flight conservation plans should be considered as goals are developed.

At the local level (land ownership and larger), biodiversity conservation plans should contribute to achievement of regional goals based on the scale and context of the land involved and economic considerations. Actions in local-level plans that contribute to the achievement of regional goals should be in accordance with site-specific objectives and should be considered as an important voluntary indicator of contributions to the conservation of biodiversity. Monitoring progress towards achieving the objectives will require that the variables that address habitat, the faunal community, and relevant metrics be defined.

With these premises in mind, we recommend the following approach for documenting sustainable management of natural and managed forest ecosystems with due consideration for conserving biological diversity. First, the management entity should commit to enhancing biological diversity and express it in a written plan with clearly stated short- and long-term goals and objectives. The main components of biodiversity to be addressed in the plan should be identified and prioritized with input from outside entities. Priorities should be assigned based on criticality and achievability.

Once goals and objectives of the plan have been defined, it is important to find measures for monitoring the effectiveness of these actions. Simple metrics might be best in many cases. For example, variables such as the number of regeneration areas with snags and retention trees or the density of snags and retention trees might be sufficient to establish a baseline and document progress toward increasing snag resources. Plans also should include provisions for periodic review and revision; participation in one or more of the sustainable forestry certification programs typically provokes such opportunities.

Research Needs

Finally, meeting several research needs would facilitate the development of meaningful biodiversity/wildlife metrics. First, there is a

need to develop a process for defining sustainable forestry and biodiversity goals on a regional basis. The diologic model presented by Williams and Matheny (1995) and Patterson et al. (2000) holds promise as a process that incorporates public dialogue, science and information, and educational opportunities.

Second, there is a need to assess the current state of biodiversity on a regional basis using a GIS-based land or habitat classification system. The classification system should be hierarchical and consistent with or able to integrate with commonly recognized classifications such as described by Bailey (1995). The assessment should include aquatic environments, habitats for species of special concern, and biotopes or unique areas.

Third, there is a need to identify focal species or species groups whose occurrence and abundance may reflect regional biodiversity status. These species should live primarily in forests, their populations should potentially be affected by forest practices, and they should include area-, dispersal-, resource-, and process-limited species (Brown et al. 2001).

Finally, there is a need to establish cause-and-effect relationships between forestry practices and biodiversity/wildlife metrics. Manipulative studies with replication and pre- and post-treatment experimental design will be necessary to establish and validate these metrics.

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Notes

Family Forestland Owners of the Lake States: Timber Harvest Activities and Implications for Sustainable Forest Management

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Introduction/Objectives

There are an estimated 21.1 million hectares of forestland in Michigan, Wisconsin, and Minnesota—the Lake States. These lands provide benefits such as timber products, wildlife habitat, recreation opportunity, and watershed protection. Land managers, particularly managers of public forestlands, often have strategies to ensure that the values provided are not diminished over time. In the Lake States, 41% of the forestland is publicly owned. The other 59% of the forestland area is privately owned and held by three broad owner groups—industrial, timber investment management organizations (TIMOs), and family forestland owners. Industrial and TIMOs own forestland primarily for timber production. Family forestland owners who control almost 90% of all privately owned timberland in the Lake States have an array of reasons for owning land. Family forestland owners are people who have a familial relationship, or who have a relationship based on common interests or goals. Family forestland owner holdings range in size from 4 to 2,025 ha (10 to 5,000 acres). Forestland holdings of less than 4 ha are generally associated with a home site and forestland holdings of more than 2,000 ha are generally corporate or industrial forests. Family forestland owners play a huge role in providing timber and other benefits from forests because they control much of the forest landbase.

Over the years, the character of family forestland owners have changed because of increasing population, improved infrastructure, and preferences for living and recreating in wooded environs. Demands and expectations placed on forestlands also have dramatically changed. Today, family forestland owners face a myriad of constraints and opportunities in holding forestland and producing timber. New research is required to understand how the dynamics of ownership affects timber resource sustainability.

The third National Woodland Owners Survey (NWOS) was commenced in 2001 to increase the understanding of woodland owners. Under the legislative guidance of the Forest and Rangelands Renewable Resources Planning Act of 1974, the USDA Forest Service has been charged with monitoring the forest resources of the United States. Landowners are the key link between society and the land and are a fundamental component in assessing forest resources sustainability. The USDA Forest Service implemented the NWOS to increase the understanding of private woodland owners with an emphasis on family forestland owners. Two key functions of the NWOS are to facilitate the planning and implementation of forest policies and to support forest sustainability assessments in the United States.

The specific objectives of the NWOS are:

- to characterize the land holdings, the ownership and management objectives, and the demographics of the private woodland ownerships
- to assess the flow of market and non-market goods from private woodlands
- to measure the characteristics of participants in federal and state forestry incentive, education, and technical assistance programs

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- to quantify the use of forest management practices including sources of information
- to assess landowner perceptions of the health of their woodlands, and
- to ascertain the constraints that are hindering private woodland ownerships from meeting their objectives

To accomplish the objectives of the NWOS, questionnaires are mailed to individuals and private groups that own the woodlands where the USDA Forest Service Forest Inventory and Analysis program has established forest monitoring plots. Twenty percent of these ownerships will be contacted each year with complete samples being completed in calendar years ending in 2 or 7 to coincide with national census, inventory, and assessment programs. The target accuracies of the data are plus or minus 10% at the state level.

Approach

In the spring of 2002 as part of the nationwide NWOS, questionnaires were sent via mail to 1,006 forestland owners in the Lake States. One-hundred forty questionnaires were undeliverable and 3 respondents indicated they had no forestland. Those owners were removed from the sample. Five-hundred eighty five questionnaires were returned for an overall response rate of 68%. Individual state response rates were Michigan—66%; Wisconsin—67%; and Minnesota—73%.

Results and Discussion

There are an estimated 488,000 family forestland owners in the Lake States owning an estimated 10 million ha of forestland. Since 1994, the number of family forestland owner in the Lake States has increased by 9%. Over one-quarter of the land owned by family forestland owners is held by people 70 years of age or older. Nearly half of the forestland owned by family forestland owners have been owned for at least 25 years. The majority (71%) of family forestland owners hold between 4 and 20 ha (10 and 49 acres). Only 7% of these own forestland primarily for timber production. Most own forestland for values relating to quality of life, such as a place for a home, recreation, or as a place to leave to heirs. Nonetheless, timber is harvested from land owned by family owners. Forestland owners that have harvested timber own 72% of the family forestland base. Half of those owners have harvested within the past 5 years. Timber harvesters tend to have larger holdings than nonharvesters; i.e., harvesters own an average of 25 ha compared to 14 ha owned by nonharvesters. Firewood and sawtimber were the most commonly harvested products. In addition, owners of larger holdings were more likely to harvest other products, primarily pulpwood.

Harvesters gave a wide variety of reasons why they harvested timber from their land. The primary reasons were to improve quality of remaining trees, part of a management plan, and to remove storm-damaged trees. Relatively few owners harvested because they needed the money.

Only 8% of the owners have a written management plan. However, those owners with a written management plan own 18% of the family forestland area. Although few owners have written management plans, they tend to seek advice about forestry related issues. Twenty-three percent of owners, holding 35% of the family forestland base, have sought advice about their forestlands. The most common sources of information were private consultants, state forestry agencies, and loggers. At the time of their most recent harvest, about 40% of owners used professional assistance. The most useful sources cited for learning about managing forestland were talking with foresters, and reading publications and newletters.

Family forestland owners performed a wide variety of activities to improve their forestland. Trees were planted on about one-third of the land owned. Other activities conducted on more than 20% of the land owned included wildlife habitat improvement projects and non-timber product improvements. No improvements were

made on about one-third of the land. Landowners primary concerns are taxes, trespassing, and being able to leave a family legacy.

Conclusion

Family forestland owners are a diverse group motivated by multiple objectives. Most people do not own forestland primarily for timber production, and they do not actively practice forest management. However, many harvest timber from their land. Timber harvesters tend to be owners who have larger tracts of forestland. In recent years the number of family forestland owners have increased. Much of the increase is among owners holding between 4 and 20 ha. Many of these owners acquired forestland for reasons relating to quality of life. An important concern for the forest resources sustainability is the extent to which owners of smaller holdings are willing to practice forestry management. Presently only 8% of family forestland owners have written management plans. A key challenge to sustainable forest management among family forestland owners is to offer technical assistance, including cost-sharing, to increase sustainable management initiatives. Programs with the greatest potential for success should target those owners whose objectives are most consistent with sustainable management. In terms of sustainable timber management, incentives should be directed to the larger tract owners because they are more likely to harvest timber and make improvements to their land.

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Establishing a Common Data Set for Planning: Social and Economic Assessment for Michigan National Forests

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One issue identified in efforts to establish indicators for sustainable forest management is the lack of common data sets or common data collection protocols. This issue is also relevant for forest planning where each planning process tends to use data that are not often comparable across plans. The results are reports and plans that are not easily compared, increased effort and time on the part of forest managers as they attempt to locate and analyze needed data, and ultimately, the use of the most readily accessible rather than the best data. This situation will only be exacerbated by the increasing emphasis on criteria and indicators in sustainable forest management, including efforts to link local, regional, and national data as well as data across time. This paper reports on an effort to address this issue by developing a common set of social and economic data for planning for the 3 Michigan national forests. The focus is on available secondary data as well as identification of variables for which primary data may need to be collected. The development of such a data set allows the 3 forests to plan together based on common information and provides a baseline that can be used in future rounds of planning.

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Canadian Forest Ecosystem Classification: A Component of the International Classification of Ecological Communities

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Introduction

The Canadian Forest Ecosystem Classification (CFEC) can be thought of as a "dictionary" of Canadian forest and woodland ecosystems. It will integrate knowledge of vegetation communities in relation to environmental gradients, such as regional climate and site-specific moisture and nutrient regimes. The Canadian Forest Ecosystem Classification will be effective for a broad range of applications, from exchanging forest management information across provincial and territorial boundaries, to identifying ecosystems with high potential for biodiversity conservation.

Currently, provincial and territorial forest ecosystem classifications identify and describe over 4,000 forest and woodland community types in Canada. However, because each classification is only consistent within its jurisdictional boundaries, direct comparison of the systems is not possible. The objective of the Canadian Forest Ecosystem Classification is to address this situation by correlating the provincial and territorial classifications into a common national system. Furthermore, the adoption of internationally standardized definitions will allow Canadian Forest Ecosystem Classification types to correspond to associations (plant communities) of the International Vegetation Classification (IVC) in Canada and the United States. In this way, forest and woodland ecosystems across Canada and the United States will be described in common terms and communication of species- and community-level ecological information will be facilitated within Canada and internationally.

Approach

The Canadian Forest Ecosystem Classification is using definitions and conventions consistent with those of the International Vegetation Classification. Because of this consistency, CFEC types will constitute the first component of the broader Canadian National Vegetation Classification (CNVC). The IVC system has been endorsed by the federal government of the United States as its national standard for vegetation classification, known as the U.S. National Vegetation Classification (USNVC). The CFEC types will be comparable to existing U.S. forest and woodland associations and alliances that either approach or extend across the international border. The CFEC is being developed by correlating existing provincial and territorial forest ecosystem classifications (FECs) and using, wherever possible, original FEC data. The expertise of regional ecologists is essential for conducting these inter-jurisdictional correlations and for reviewing the CFEC types. Subsequently, IVC data and ecological expertise from NatureServe and regional conservation data centres will be applied to the correlation of CFEC types with U.S. forest and woodland associations and alliances. Ultimately, it will be possible to relate CFEC types to provincial and territorial community-scale FEC units, as well as to the CNVC and the USNVC associations and alliances. Linkages with the National Forest Inventory and satellite-derived land cover schemes will provide the capacity to add ground-level ecological information, thus helping to meet national and international reporting requirements for the Biodiversity Convention and for Criteria and Indicators for Sustainable Forest Management.

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Results and Discussion

The Canadian Forest Ecosystem Classification (CFEC) when completed will include:

1. A national list of standardized, community-level forest and woodland ecosystems that are defined and described in terms of vegetation characteristics in relation to climate, site and ecological processes. Each CFEC type will be equivalent to an association of the Canadian National Vegetation Classification and the U.S. National Vegetation Classification.

2. A classification database containing summaries of ecological attributes for the CFEC types (associations) and their first-order aggregates (alliances). The database will include information on community structure, plant species characteristics, habitat and biogeographic attributes, and ecological process relationships.

3. Linkages with nationally and regionally mapped ecological entities, such as the National Ecological Framework for Canada, and with national reporting structures, such as the National Forest Inventory.

Since its inception in 2000, the CFEC project has established a national network of regional forest ecologists to synthesize existing forest ecosystem classifications within provinces and territories of Canada. At present, a harmonized classification of the forest and woodland communities of the Boreal zone of western Canada (including British Columbia, Yukon, Alberta, and Saskatchewan) is nearing completion. Peer review, with western regional ecologists, of proposed western boreal forest / woodland associations / sub-associations has been completed, with agreement on concepts for approximately 40 associations. The province of Quebec has completed synthesis of its provincial "types forestiers" into new "Grands types forestiers". These will form the basis for harmonization with standardized forest types in the province of Ontario, which are currently being synthesized by the OMNR. Peer review of proposed forest / woodland associations for the Maritimes provinces was completed in December 2002, with ecologists from Nova Scotia, New Brunswick, and Prince Edward Island, and revised association concepts and descriptions will be completed by June 2003.

To ensure good collaboration between the CNVC and CFEC projects a Steering Committee and a Technical Committee, representing potential users and developers of the classifications, have been established to exchange information, monitor progress, and ensure that everyone is following the same definitions and standards. A first approximation of CNVC forest and woodland alliances will be completed this year by NatureServe Canada. Revision of upper levels of the IVC hierarchy by stakeholders in the U.S. and Canada is pending.

Activities for the coming year will include: (1) completion of correlations for the montane and sub-alpine associations of western Canada; (2) synthesis of standardized forest types within Ontario; (3) standardization of the Newfoundland and Labrador FEC database; and (4) harmonization of the Maritime and Québec forest types. A final national harmonization of the regional forest / woodland associations will be initiated in 2004.

Conclusions

The establishment of a harmonized Canadian Forest Ecosystem Classification and associated Canadian National Vegetation Classification is an enormous task that has shown steady progress since 2000. The success of the project continues to be driven by a broad collaboration with ecologists throughout Canada and the United States, who bring their regional expertise and data to the project and work to mutually agreed standards. The following is an abbreviated list of the principal contributors.

CFEC Project Coordination

Ken Baldwin	CFS -GLFC
Ken McIlwrick	CFS -GLFC
Brenda McAfee	CFS-HQ

CNVC Steering Committee:

Steve Curtis (co-chair)	NatureServe Canada
Bill Meades (co-chair)	CFS - GLFC
Don Faber-Langendoen	NatureServe
Ken Baldwin	CFS - GLFC
R.A. Lautenschlager	Atlantic Canada Conservation Data Centre
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Donald McLennan	Parks Canada
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CNVC Technical Committee:

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Notes

Challenges of the Changes in Wisconsin's Northwoods

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Introduction

This paper will discuss three changes that are creating challenges for the management of northern Wisconsin forests, focused mainly on private ownership. The first change is the increase in the number of owners and the small size of parcels. The second is the push to certify the sustainability of forest management ,and the third is the lack of understanding by most people of forest management and what our forests provide.

Parcelization and Fragmentation

During the past decades much industrial forest land has been sold to individuals and many local residents have sold parcels to nonresidents. This parcelization raises concern about the potential loss of forest product production, and about ecological fragmentation. One challenge is to be clear that parcelization is not the same as ecological fragmentation. The term ecological fragmentation refers to disruption of the habitat for various species or groups of species by breaking up the forest into disjunct tracts. All too often the word fragmentation is used to describe parcelization. Prices for woodland and property taxes on woodland have both skyrocketed in recent years. Buyers of woodland may want to live out in the country or in the woods but may be unable to afford more than 5 or 10 acres (2-4 ha). Developing subdivisions with multiple roads and houses creates many very small parcels and can result in ecological fragmentation.

Other situations exist where tracts of one to several parcels of 40 acres (16 ha) are purchased by individuals or small groups. These parcels don't necessarily create forest fragments. Many of those who purchase these woodlands have some appreciation that it has value though they may have differing views as to what is of value. The 'value' may or may not be rooted in forest product production. The value may be just that it is open space or if they are primarily interested in hunting, the value may be that there are 'a lot of deer' on the property. With the rise in value, property taxes have also risen sharply. Owners want to reduce their tax bill and get some revenue from the land. In Wisconsin, owners can reduce woodland property tax by entering the land into the Managed Forest Law (MFL) program. The program allows only productive or potentially productive forest lands and requires a long-term forest management plan. The plan will require planting, thinning, improvement cuts, and harvests at appropriate times based on the conditions and owner objectives. In return, owners benefit from property tax deferment.

Whether or not woodland owners enter land into the MFL program, there is a strong incentive for getting revenue from the land. Since I retired, I have done some consulting and have been active in Wisconsin Woodland Owners Association. These two areas of involvement have put me in touch, and out in woods, with a fairly large number of woodland owners. One example of the new type of ownerships is where a group of 4 individuals purchased 120 acres (48 ha) in one block and a separate 40-acre parcel. They purchased the land for hunting and general enjoyment and intend to manage for wildlife and forest products. To offset the costs, such as property taxes, trails, and food plots they are interested in revenue generated by growing and harvesting the best quality timber they can. I could cite many similar examples. These are small parcels and it could be said that the land was becoming parcelized. However, because the areas are not being carved into smaller blocks with houses and lawns, it is difficult to claim the area is fragmented. Even

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where the owners have erected a cabin or some sort of small living/storage building within their acreage, this is not likely fragmenting the habitat of even a few creatures. My point is that ownership by individuals or small groups is not inherently bad. We should work to educate owners on the importance of proper management, provide incentives and refrain from creating a situation where woodland ownership of smaller parcels by individuals is over-regulated or denied. The MFL program is one strong incentive and efforts should be continued to keep it fair, strong, and well used.

Sustainability and Certification

Along with the concern over parcelization, there is concern about forest sustainability and a push to certify sustainability. New owners often are very interested in managing their lands and want to maintain their forest and enjoy its entire spectrum of benefits. Some would concentrate more on products and others more on visuals, wildlife, or recreation in various combinations. These owners hear all the talk of sustainability and certification and ask the simple question, what is it? The word sustainability and the purported need for certification also confuses many landowners who have been managing forest lands for decades. They may have a full-canopied forest with younger saplings and pole sized trees coming along. They ask, haven't I been managing in a sustainable manner? Why do I need to be certified? Currently the answer depends too much on whom you ask. For private forestry there is a need to get the idea of sustainable management of forest lands clearly defined in terms of what the forest needs to continue as an ecologically productive forest. Other social, political, or community objectives must be dealt with separately.

In 2004, Wisconsin celebrates its forestry centennial. For much of that time, the state has been a leader in promoting good long-term management of forests. I was in high school 50 years ago when a forester from the state marked an improvement cut for my father. The forester didn't use the exact terminology that we use now but the concept was the same. Now I own that land and the fourth improvement and harvest cut was done this past winter on the same stands. Also when I was in high school my father bought stumpage, and we logged county forest land near our farm. The aspen stands we clearcut have gone through many further entries. Some stands were clearcut again to maintain aspen on sites best suited to aspen. Other stands on more well-drained sites have gone through normal successional stages for the area and are now beautiful maturing pole and small sawlog northern hardwood stands. All the townships around where I grew up now have forests we didn't have 50 years ago. Forests were decimated. They've been revived! Do we need 3rd party approval in light of what has been accomplished? In spite of the revival there is still a lack of quality management. Much effort is needed to get active long-term management on a much higher percent of the forested acres. Not that all forests need to be managed alike. Different owners have different objectives.

Rather than a rigid recipe like those needed to create one of Harry Potter's potions, prescriptions for forest sustainability are more like bread recipes. My mother was a bread baker — a fine bread baker — but she was also baking to feed seven hungry mouths at a reasonable cost. As a result most days we ate excellent basic white yeast bread. I have become a bread baker for my wife and I and have the time and inclination to experiment. I find that one can make great breads by varying the type of fat. One can use all water or water and milk in varying portions. You can use eggs or not and greatly vary the amount of sugar or other sweetener. Good tasty, bread can be made in a multitude of ways. Some will like one kind better than another. Forests also can be managed in a multitude of ways and still be sustainable. Some folks will like one set of management prescriptions better than others. The focus can be on high-quality log production, volume of fibre, maximum wildlife habitat, or visual resources. There is no reason that a focus on

one of the many resources should preclude realizing value from the other resources. And this can all be done in the context of sustainability. It's not magic, its management! Efforts to involve landowners and increase intentional management are needed.

Getting Folks Out to the Woods

Because we are increasingly an urban, suburban, and ex-urban population, a third challenge is to improve understanding among non-owners of what is going on in our forests. There are important issues and concerns but the situation is not all negative. It seems that some of the divisions that spring up in Wisconsin and the neighbouring areas are because a very large segment of the population is uninvolved and their support is sought by two or more rather different viewpoints. I propose increased efforts to get forest owners and non-landowners and rural and non-rural folks **out in the woods** to walk and talk with each other and to see for themselves what is happening. Would it be possible, feasible, doable to get a significantly larger part of the population out in the woods? I'm not talking about putting them through Forestry 101 to 201. It may or may not even be critical to have a defined educational program. I'm just suggesting we need to work at inviting more folks out for general education and enjoyment. WWOA, the Tree Farm program and forest industry companies have many field days. Typically we invite members and others owners to attend and we have interesting, educational and fun programs. All of these efforts are important and needed. Many WWOA members do open their woodlands school groups as well. The focus, though, has been on owners, not because we wanted to exclude others but because of time constraints and perhaps a limited perspective. We should expand our efforts by inviting a broader community.

We could model these efforts after the Society of American Forester's (SAF) *Walk in the Woods*. The walks could be mostly for enjoyment or more directly educational with plant identification and management explanations. Besides private and public demonstrations areas, there are many school forests. These lands were deeded to school districts during the early settlement days. Some are actively used by students and teachers, others are not. I propose that those of us interested in the public's understanding of woodlands, work with the schools that already have regular programs for the students and broaden the use of those school forests by initiating *woods walks* for all ages at different times of the year. We should also look to broaden our partnerships. For example, we could join with the Ice Age Trail Foundation and its local chapters to foster walks that increase understanding of forest management as well as the understanding and enjoyment of the woods and its many attributes. Some of our WWOA members already are doing this. There are other organizations with whom we could work. New family-oriented clubs, such as The Chequamegon Wildlife and Recreation Club and birding clubs, have a general interest in the outdoors and in forests. Perhaps we could work out exchange visits with garden clubs and get to know and work with second-home owner groups. The possibilities may seem endless but the need is great and even partial success will provide paybacks.

Summary

As discussed, many changes are occurring in northern Wisconsin's woodlands. These changes require adjustments in how we think about and use the forests. Not all changes are negative and I feel that education and incentives are preferable to attempts at legislating and regulating forest management approaches. Sustainability is easily accomplished through management. Most importantly, we must also work with those who don't own woodlands to help them understand what forest management can accomplish.

Notes

Adapting Multi-criteria Analysis for Sustainability Assessment in State of the Forest Reporting in Ontario

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Ontario's *State of the Forest Report, 2001* in large part is based on 67 indicators within 7 principles of sustainability. To take the State of the Forest Report from a simple report on forest conditions to an evaluation of forest sustainability the Ministry of Natural Resources has been adapting Multi-Criteria Analysis methodologies to allow for a broad-based assessment of forest sustainability. A multi-criteria evaluation method has been developed and tested by the Centre for International Forestry Research (CIFOR) and presented in their Toolbox No. 9. The Province of Ontario, Canada, elected to pursue development of these methods for provincial scale criteria and indicator reporting. As part of the development of its first report, an initial assessment was undertaken in a series of workshops with subject matter experts.

For the next State of the Forest Report it is proposed that sustainability assessment be carried out by a range of individuals from stakeholder groups, subject matter experts, and the general public. To accomplish this a variety of tools and procedures have been/are being developed. The tools extend the CIFOR methods by allowing for stratification by interest groups and compilation of individual responses to minimize observer bias. These extensions of the methods for inclusiveness beyond collective expert opinion will allow examination of the various perceptions of forest sustainability. The debate about progress towards forest sustainability can be documented by a quantified analysis. Credibility for sustainable forestry evaluations should be improved by developing objective academic, industry, public, and environmental non-government organization counterpoints to an agency's self-evaluation.

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Notes

Development of a Criteria and Indicators Framework in Ontario

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Sustainable forest management is the foundation for all current forest policies in Ontario. The province has taken a proactive approach towards forest sustainability by developing a comprehensive set of policies and legislation relating to sustainable forest management. Keystone legislation and associated policy documents commit Ontario to sustainable development and an ecological approach to forest management, and provide the foundation for continued development of policy and legislation related to forest sustainability. In order to fully define and report on forest sustainability at the provincial scale, Ontario's Ministry of Natural Resources developed a complete set of forest sustainability indicators for Ontario, in the context of a broader and more comprehensive sustainability evaluation and reporting framework.

This evaluation framework is a structured and documented guide that outlines how sustainability evaluation will be accomplished. OMNR developed a framework that describes what is being evaluated, the intended users and uses of the information, the issues and questions to be addressed, the sources and methods used to collect the information, and the frequency of data collection. The evaluation framework provides a useful "road map" and set of "sign posts" for evaluating progress in sustainable forest management.

The sustainable forest management process has several stages. The planning stage includes the development of management objectives, which are then implemented through approved forest-management plans. The monitoring stage involves the collection of data related to the implementation of management decisions and the expected effects of those decisions. The evaluation stage determines whether the management objectives established in the planning stage were achieved, and whether these objectives continue to be desirable and achievable. The final stage, reporting, ensures that information from the planning, monitoring, and evaluation stages is presented to managers and stakeholders in an organized format, for input into future decision-making and objective-setting.

Monitoring of forest sustainability requires careful sampling design, data collection, and data management. Sampling design is important because it may not be practical or possible to collect the desired data for all indicators. Since data collection is expensive and time consuming, monitoring programs need to be focussed and efficient. Forest monitoring programs can generate large data sets that require temporal and spatial referencing, making effective data management critical. Monitoring is driven by the need to get data trends over time for each chosen indicator. Learning that can be applied in future decision-making is enhanced when monitoring data can be compared to indicator predictions following the implementation of management decisions. Monitoring programs are most effective when designed with the explicit intention of testing specific forecasts or predictive mathematical models.

The goal of evaluation is to render judgement. In evaluation, monitoring data are analyzed and interpreted to make at least two kinds of decisions: to determine whether management hypotheses and forecasts are valid, and to determine whether management actions are moving indicators in the desired "sustainable" direction. In determining whether progress towards sustainable forest management is being achieved, a crucial issue is determining whether the trends measured by specific

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indicators are indeed the result of forest management practices. Evaluators will need considerable insight if they are to draw valid conclusions, as other factors may confound the links between management actions and sustainability indicators. Distinctions that relate the scope of conclusions to forest management influences will be required.

Reporting is the final stage of the sustainable forest management process. The reporting stage ensures that the information planned for, collected, and evaluated in previous steps is presented to stakeholders in an organized format and is used for future management planning purposes, which includes input into decision-making and modifications to future management actions. For efficiency's sake, OMNR sought ways to have various types and scales of sustainability reporting link where possible. Streamlining of the reporting process was accomplished by combining all required longer-term reports into one comprehensive volume - a "state of the forest" report. This report evaluates forest sustainability every 5 years, and assesses results within the framework of Ontario's forest sustainability criteria and indicators-based evaluation framework.

OMNR used the Canadian criteria and indicators as the basis to develop a set of criteria and indicators unique to Ontario that would fit within Ontario's proposed overall sustainability evaluation framework. OMNR included a seventh criterion from the Montreal Process, to encompass Ontario's legal and institutional framework. The 7 Ontario criteria are expressed in the form of sustainable forest management goals.

The perspective in OMNR's criteria and indicators system differs from other systems, in that goals and objectives set the policy context for all the indicators. The goals and objectives are based on public policy and values, and signify commitment to those values. These values are the driving force for sustainable forest management. The indicators themselves are a monitoring tool and a means to assess how well OMNR is achieving specific policy goals and objectives. This system allows for a separation of public values and scientific assessment, which are combined at the indicator level in most other criteria and indicators systems.

Ontario has also linked the criteria and indicators approach to provincial forest management guidelines, compliance, and audit. The implementation of management actions is monitored on the ground using a provincially coordinated compliance verification system. The overall forest management planning, public consultation, implementation, and monitoring system is verified through the use of Independent Forest Audits on each management unit. In cases where direct information about the effects of forest management is limited or difficult to obtain, the goals, objectives, and indicators are linked directly to the guidelines, compliance, and audit system.

The approach used in Ontario's criteria and indicators framework provides a comprehensive, continuous and seamless system, from high-level goals at the criterion level right down to the indicators themselves, all anchored in public policy. A rationale for the selection of each indicator, drawn from scientific and technical literature, provides a scientific grounding for the indicator monitoring and assessment carried out under the criteria and indicators framework.

The development of Ontario's criteria and indicators framework has been carried through to implementation, in the form of Ontario's State of the Forest Report, 2001. This report culminates the development of Ontario's criteria and indicators framework, linking high-level policies of sustainable forest management with detailed public reporting of the best information currently available for 63 indicators of sustainable forest management. The evaluation of these and other indicators is continuing. Over time, the results of this evaluation will be incorporated in adjustments made to policies, program direction, and on-the-ground forest management practices, to provide for the long-term sustainability of the forest

resource. This evaluation will also provide input and direction, through an adaptive approach, for ongoing refinements to Ontario's criteria and indicators framework.

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Notes

The Contiguous Forest – Benefits and Parallels of the Urban and Rural Forests

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Assessments of urban forests in Minnesota reveal that there are currently 128 million trees in urban areas with a compensatory value of $80 billion dollars. These urban forests provide services and benefits that are often under priced, under appreciated and under funded. Trees, both urban and rural, play a vital role in the environmental, social, and economic welfare of a healthy sustainable community.

With approximately 80% of the public living in urban areas, urban forestry is what links people to trees, and to the rural forests. The knowledge of how trees function, their benefits and the importance of a contiguous forest is lacking and to better understand forestry one needs to understand the trees in their own back yard. To advocate for forestry funding people need to be sensitized to their interdependence with trees, the benefits that trees provide them personally and the challenges that forest practitioners face to market and manage trees for the public benefit.

Education is the basis for better understanding and through the process of education you change paradigms. Lack of education and information to the public only nurtures misunderstanding and fear. Public education and hands-on opportunities to create forest stewards will invest them into looking at trees more holistically and encourage them in gaining support for active management of rural forests for timber. It will introduce them to the research that quantifies the benefits and management practices so that they don't perceive forest resource management to be self serving. It will highlight the benefits and parallels of urban and rural forests and introduce them to the concept that all forests are part of a community's infrastructure and both must be managed with intent and as one. Forests are contiguous.

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Notes

Bioindicators of Forest Sustainability: Using Remote Sensing to Monitor Forest Condition

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Introduction

The Bioindicators of Forest Sustainability Project was initiated by MNR's Ontario Forest Research Institute in 1996 to identify and develop physiological indicators of forest condition. The project focus is to develop objective measures of condition at the stand level. While stress indicators at the leaf-level exist (e.g., chlorophyll fluorescence, and pigment content), developing reliable indicators at the stand canopy level is a challenge. The stimulus for initiating the project came from two sources: (1) international and national commitments by policymakers to develop a standard set of Criteria and Indicators of Forest Sustainability by the Canadian Council of Forest Ministers; and (2) an ongoing need for operational tools to assess the effects of forest management practices on forest health.

The capability to estimate forest condition from remotely sensed images could be readily applicable to operational assessment of forest physiological strain, and in classification of forest condition based on chlorophyll content. The practical significance of developing spectral features related to chlorophyll or other pigments is in identifying whether forests are ecologically healthy or stressed to the point where ecosystem productivity may be constrained. The objective of the Bioindicators Project is to develop physiologically based, remote sensing method of estimating stand level forest condition for (a) sugar maple (*Acer saccharum*) stands (Phase I), and (b) the boreal species of jack pine (*Pinus banksiana*), black spruce (*Picea mariana*), poplar (*Populus tremuloides*), and white birch (*Betula papyrifera*) (Phase II).

Approach

A field plot network of 12 sugar maple sites in the Algoma region of Ontario, representing a range in tree condition (chosen from existing provincial plot networks), was assessed by a leaf data collection for physiological and spectral analysis (Phase I). A validation study was also conducted to evaluate chlorophyll estimation across seasons and for a range of sugar maple sites in eastern Ontario. A second series of sites were selected in the Sudbury to Chapleau area of Ontario for jack pine (12 sites), black spruce (5 sites), poplar (8 sites), and white birch (3 sites) for the same analyses in Phase II. Single leaf chlorophyll fluorescence (Algoma maple only), reflectance and transmittance, and chlorophyll *a* and *b* levels were measured from leaves of 5 trees per site. Ground sampling of the leaves and acquisition of airborne remote sensing images was done concurrently. In this study, an inverse modelling approach demonstrated the capability of the compact airborne spectrographic imager (CASI) hyperspectral sensor to map chlorophyll content (root mean square errors ranging from 3.5 to 13.0 mg cm^{-2}) in broadleaf and conifer stands. Modelling was done first at the leaf level and then scaled up to the canopy level.

Results and Discussion

The estimation of chlorophyll in mature maple stands was done in the Algoma region of Ontario in 1998 and 1999 (Table 1). These estimations used the ratio of CASI-derived reflection at 750 nm (R750) to the reflectance at 710 nm (R710) at the red edge of the

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chlorophyll absorbance curve. This reflectance ratio R50/R710 permitted models to estimate the chlorophyll concentration of the maple sites relatively accurately in both years with root mean square errors (RMSE) running at about 15 to 20% of the levels of total chlorophyll. To determine if this Algoma area derived technique that was applicable in other areas we validated the approach in eastern Ontario where results were comparable to the Algoma region and the RMSE was even lower (Table 1).

The forest condition rating system for mature maple stands was devised from these results (Table 2). Based on the condition of the stands we worked with, we found that the upper canopy chlorophyll concentration of an average healthy stand was 30 to 40 g of total chlorophyll per cm^2 of leaf area. Concentrations below that level were described as having progressively higher probabilities of being in decline or stressed (unhealthy) condition. Now that the algorithms have been developed, future estimates of maple stand condition can be done using just reflectance images from remote sensing.

Four field sampling campaigns conducted in 2001 have produced preliminary results for estimating jack pine and poplar canopy chlorophyll (Figures 1 and 2). These results look promising with the r^2 values ranging from 0.4 for poplar to 0.57 for jack pine. The RMSEs for these estimates range from about 5 mg cm^{-2} for poplar to 12 mg cm^{-2} for jack pine chlorophyll.

Jack pine canopy chlorophyll concentration comes from both old needles and current year or new needles. Four of the 12 stands chosen were selected from a jack pine forest health plot network and were classified as stressed. In 2002 the chlorophyll concentration of old and new needles for all plots was compared and 3 of the 4 stressed sites had significantly lower chlorophyll levels but only in the new needles and not in the old needles. This suggests that for jack pine chlorophyll concentration can be used to estimate their condition but only in the current year foliage. In 2002 we estimated the proportion of old to new needles in jack pine to be approximately 3:1 in late July. This means that new needles make up about 25% of the total number of needles on a branch, which represents a significant challenge for estimating jack pine condition using chlorophyll.

The preliminary results suggest that chlorophyll estimations can be accomplished in poplar using remote sensing. Poplar has also been shown to have less chlorophyll in leaves stressed by air pollution, which suggests that chlorophyll can be used to estimate the condition of poplar stands. White birch preliminary results (data not shown) also show promise for using estimating chlorophyll with

Table 1. *SailH and Prospect Model canopy level chlorophyll correlations for 12 mature sugar maple sites of varying condition in Algoma and eastern Ontario regions.*

Year	Optical Index	r^2 (Chl a+b)	RMSE ($\mu g\ cm^{-2}$)
1998 (Algoma)	R750/R710	0.43	5.57
1999 (Algoma)	R750/R710	0.57	8.53
2000 (E. Ontario)	R750/R710	0.42	3.0

Table 2. *Forest condition rating system for selected Ontario maple stands.*

Chlorophyll a+b ($\mu g\ cm^{-2}$)	Forest Condition Rating
1 - 19	Maple in decline
20 - 24	Suspected decline
25 - 29	Possible decline
30 - 39	Average chlorophyll healthy stand
40 - 50	High chlorophyll healthy stand

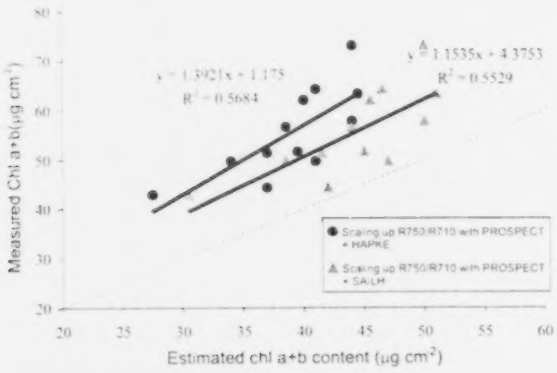
y = 1.3921x + 1.175
R² = 0.5684
y = 1.1535x + 4.3753
R² = 0.5529
Scaling up R750/R710 with PROSPECT + MAPKE
Scaling up R750/R710 with PROSPECT + SAILH
Measured Chl a+b(µg cm⁻²)
Estimated chl a+b content (µg cm²)

Figure 1. *Correlating estimated versus measured Pj canopy Chl*

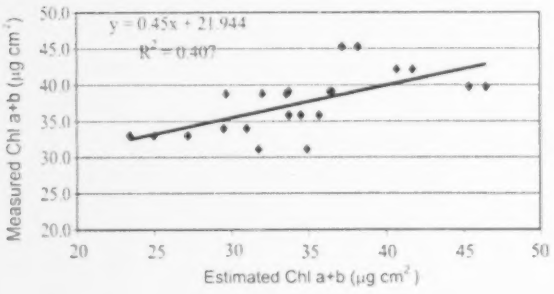

Figure 2. *Correlating estimated versus measured poplar canopy Chl*

remote sensing. Estimating chlorophyll in black spruce represents a significant challenge because of its needle size and crown shape.

Summary

- Our results suggest that remote sensing-derived estimates of maple stand chlorophyll concentration can be used to estimate stand condition.
- Developing similar methods for estimating chlorophyll in boreal species will be challenging for jack pine and black spruce but looks promising for poplar and white birch.

Notes

Breaking the Constant Climate Paradigm: Intransigence in Forestry in the Face of Impending Climate Change

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Introduction

Continued atmospheric pollution by greenhouse gases is expected to cause a rise in global temperature of 1.4 - 5.8°C, regional shifts in precipitation regime, and doubling of atmospheric CO_2 (IPCC Third Assessment 2001). Increased disturbance by wildfire, insects, diseases, and extreme climatic events (e.g., flooding, heat waves, drought, and windstorms) are also anticipated. If even the most benign climatic projection comes to fruition, the effects will be significant and will profoundly affect forests.

However, forest managers continue to operate under a "constant-climate paradigm". It is important that they begin viewing site as a dynamic rather than static concept and balancing today's forest management decisions on assumptions about the both the current *and* future climate. In this presentation, we discuss some of the ways climate change and elevated CO_2 could affect northern forest ecosystems, the implications of these effects on forest management, and what forest managers can do to minimize any negative effects.

Ecoclimatic Shifts, Forest Decline and Changes in Vegetation Distribution

Current forest species ranges are strongly related to climate of the past few hundred years (Reed and Desanker 1992). Modelling to simulate the effect of rapid climate change on distribution of forests invariably predicts northward movement of tree species (Solomon and Bartlein 1992). In regions that become warmer and drier, drought stress may initiate the decline of poorly adapted species and populations. Recently, models have simulated vegetation succession in the United States under several climate scenarios (Hansen et al. 2001). In the eastern United States, climate change would increase habitat suitable for oak-hickory forests in areas now occupied by spruce-fir and aspen-birch forests. Suitable habitat for several northern species (e.g., aspen, sugar maple, northern white cedar, and red pine) would be reduced by at least 90%. Where warming exceeded 4.5°C, forest area was reduced by 50%, being replaced in some regions by savanna and grasslands due to drought and fire. Similar reductions in forest area have been predicted for northwestern Ontario (Parker et al. 1999) and the Canadian forest-prairie ecotone (Singh and Wheaton 1991).

Climate-induced changes in vegetation will likely be centred along forest ecotones and where some forest types already occupy marginal habitat. Because of vegetation inertia, a lag in vegetation response to climatic change is expected. The rate at which vegetation change occurs is dependent in part on the tolerance of species to the new climatic regime and the rate at which climate changes (Brubaker 1986). Disturbance accelerates vegetation change, initiating succession to better-adapted species. Movement of better-adapted species and populations also depends on migration rates being adequate to keep pace with changes in climate (Brubaker 1986). The speed of species migration after the last ice age was sufficient to track changes in climate. However, post-glacial migration of trees occurred under a rate of climate change that may be up 10x slower than that projected for this century (Schneider 1990). The influence of fragmentation and other barriers to migration is of particular concern,

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especially for rare plants and those confined to isolated populations that may not migrate as fast as the climate changes. These populations and species could become extinct without human assistance.

Tree species migrate independently (i.e., plant communities do not migrate as units). By embracing a passive management approach to potential changes in vegetation distribution, foresters may unintentionally be contributing to future forests of lower ecological and commercial value. Natural disturbances are an important catalyst for vegetation changes that facilitate tree migration. If nature drives changes in vegetation, new plant communities will likely consist of early successional species adapted for rapid invasion of disturbed habitats, followed over time by colonization by more competitive, generalist species.

Harvesting and natural disturbance provide an opportunity to assist tree species migration, increasing the movement of vegetation to suitable habitats. A reactive approach is to identify forest regions that come under stress as the climate changes. Where decline occurs, thinning to increase water availability and removing trees under stress may improve stand vigour and reduce disease and fire hazard. In declining stands near rotation age, or where thinning is not economically viable, stands should be harvested and regenerated with site-adapted species.

Planting a variety of genotypes and species or planting at elevated densities can be a hedge against climatic uncertainty (Ledig and Kitzmiller 1992). These areas provide opportunity for movement of more southern species and genotypes of native species up to 200 km north of current ranges (Ledig and Kitzmiller 1992). This will require screening, identification, and operational production of climatically adapted genotypes and species to support these artificial regeneration efforts (Rehfeldt et al. 1999).

Increased Incidence of Natural Disturbance

The most obvious and immediate effects of climate change are expected to occur through increased frequency, intensity, and geographical extent of natural forest disturbance by insects, diseases, fire, and drought. Insect pests and diseases are sensitive to climate and will be among the earliest evidence of climate change (Hepting 1963). Climate change is expected to significantly increase wildfire in some regions (Flannigan et al. 2000). With expected changes in temperature and precipitation, the Canadian GCM predicts an increase of over 30% in seasonal fire severity for most of Canada north of the 48th parallel. Increases in the seasonal fire severity of 40% are predicted for much of northwestern Ontario, northern Manitoba, and British Columbia. Climate change may also increase fire activity by increasing the length of the fire season (Wotton and Flannigan 1993). Climate change-induced forest decline and increased disturbance by insects and disease will increase the fuel load and thereby further increase wildfires.

Increased frequency of natural disturbances will significantly affect wood supply by destroying fibre prior to harvest and by preferentially eliminating higher yield older stands. More aggressive fire management could reduce area burned. This will require additional funding and infrastructure, but increased investment in traditional approaches will eventually yield diminishing returns. A more proactive approach is to embed fire management into everyday silviculture and forest management to manage forest fuels and facilitate future fire suppression activities (Hirsch et al. 2001). Selective use of 'fire-smart' management over the next few decades in areas where wildfire is projected to increase under climate change could help reduce area burned.

Forest Productivity

Increasing atmospheric CO_2 and temperature potentially can increase forest area and productivity (Jenkins et al. 2000, Saxe et al. 2001). Joyce and Nungesser (2000) predict changes in NPP in the conterminous United States under doubled CO_2 using two climate change scenarios. Increases of between 20 and 40% in the northeastern and Lake States forests and much of the forest area in the Pacific

northwest is predicted to increase net primary productivity by more than 40%. However, where moisture stress or low nutrient availability occurs, positive effects on productivity will be substantially less (Jenkins et al. 2000). Forest productivity is also projected to vary with time, first increasing (5-30%) under the modest warming and elevated CO_2 expected within the first decades of this century. At greater levels of warming, the positive effects of CO_2 may be reduced, with decreased productivity (>-20%) occurring, particularly where precipitation remains unchanged or is reduced. Other stress agent, such as ozone and increased fire frequency, may also prevent the realization of potential future increases in productivity (Saxe et al. 2001).

Sustainable forest management practices will help to maintain healthy, diverse forests that will be more resistant and resilient to climate change-induced stresses. Timely application of adaptive measures to climate change will also contribute to maintaining long-term forest productivity. As mentioned, maintaining and enhancing forest productivity in the event of climate change will require human intervention to move species and genotypes to suitable habitats and minimize forest area disturbed as already mentioned (Rehfeldt et al. 1999). Additional measures to improve forest productivity to compensate for climate change-induced losses due to regional forest decline and disturbance include more intensive forest management now and in the future, and the use of genetically improved planting stock with higher growth rates, insect and disease resistance, and photosynthetic sensitivity to high CO_2.

Conclusions

Climate change promises to dramatically affect the composition, structure, function, and productivity of forests. Reductions in greenhouse gas emissions under the terms of the Kyoto Protocol will not prevent a doubling of atmospheric CO_2, and at best will delay it by a few decades. This comes at a time when forests are already stressed by other agents (e.g., ozone, N deposition, fragmentation, exotic species), diminishing their resistance to additional stress from climate change.

Reducing the adverse effects of climate change is dependent in part on the recognition by forest managers that changing climate is inevitable. However, managers also must be provided with the tools and direction to implement adaptive measures that can diminish negative effects of a warmer, more variable future climate. This includes better prediction of the anticipated changes in climate, their potential effects on forest ecosystems, monitoring of forests to identify regions requiring silvicultural intervention, and the development of viable approaches for adaptation of forests to climate change. In this way, proactive and reactive measures to reduce the potential negative effects of climate change can be applied to affected forest regions in a timely manner, avoiding the potentially destructive consequences of adhering to the constant-climate paradigm.

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Notes

Smart Growth Planning and Sustainable Forestry: Is *Smart Growth* Smart for Great Lakes Forests?

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Introduction

The *Smart Growth* movement, which is largely an attempt to bring the goals of sustainability to the planning of urban, suburban, and rural areas, has achieved a significant foothold across the Great Lakes region in recent years. Since *Smart Growth* and sustainable forestry share important core principles, and all of the states and provinces that comprise the Great Lakes Forest Alliance (GLFA) have now initiated *Smart Growth* land use planning reforms, it is imperative that the forestry community become more actively involved in the *Smart Growth* debate. By proactively shaping and supporting the *Smart Growth* agenda, advocates of sustainable forestry can better ensure the health of our forests, the vitality of our forest products industries, and the scenic and recreational values of our forestlands.

Discussion

In recent years ,the advocates of *Smart Growth* have managed impressive successes in advancing their political agenda. *Smart Growth* reforms of one kind or another have been adopted by a large number of American states and Canadian provinces and, in what is surely the best indicator of an issue's place in the political ether, heated words are being exchanged in the opinion sections of local newspapers and politicians are busily triangulating the issue. In the midst of the sometimes-raucous *Smart Growth* debate, one might, perhaps, be forgiven for missing the fact that there is actually no broadly accepted definition of the term. There are almost as many definitions of *Smart Growth* as there are groups interested in land resources and what we choose to do with them. In lieu of further muddying the already murky waters with another definition, it may make sense to take a look at what *Smart Growth* is, and what it is not.

There is a widely held misconception that the *Smart Growth* movement is primarily interested in urban issues. In reality, *Smart Growth* is highly concerned with rural communities, especially those areas that are threatened by suburban sprawl[1]. By promoting denser suburban development and infill in urban areas, *Smart Growth* advocates hope to minimize the conversion of prime agricultural, forest, and other open lands. A second misperception of *Smart Growth* is that it proposes radical changes to the ways in which North Americans buy, sell, and use their land. *Smart Growth* is not revolutionary; it is really just a package of new and traditional, related and unrelated, programs and policies that add up to not much more than the definition of good city and regional planning that has existed since the beginning of the last century. According to the Smart Growth Network, *Smart Growth* is defined by the advocacy of policies that aim to, among other things, create a range of housing opportunities and choices, foster community consensus and collaboration, make development approval processes more predictable, fair and cost effective, and preserve open space, farmland, natural beauty, and critical environmental areas.

[1] Sprawl is, if anything, harder to define than Smart Growth. It has been said that, like pornography, sprawl is probably not very good for people, though it does seem rather popular, and, in the words of Justice Potter Stewart, you "know it when (you) see it."

Rose, L.E. and A.H. Perera (comps). 2003. Meeting emerging ecological, economic, and social challenges in the Great Lakes region: Popular summaries. Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. For. Res. Inf. Pap. No. 155.

While their programs are in some ways as various as the definitions of the term, each of the four states and provinces that comprise the GLFA has adopted *Smart Growth* reforms in recent years. In Michigan, Democratic Governor Jennifer Granholm and Republican State Senator Ken Sikkema collaborated on the creation of a *Smart Growth* Commission charged with "curbing urban sprawl and giving communities more tools to preserve open space."[2] In Wisconsin, *Smart Growth* planning legislation, enacted in 1999, requires that most municipalities adopt a comprehensive plan by 2010 and offers state funding to those that meet Smart Growth planning criteria. Following the guidance of it's 1996 Sustainable Development Act, Minnesota's State Office of Strategic and Long Range Planning has developed guides and model ordinances designed to help local communities foster development that "meets the needs of the present without compromising the ability of future generations to meet their own needs."[3] In Ontario, the provincial government has created a Smart Growth consortium of 10 provincial ministries, including the Ministries of Agriculture and Food, Natural Resources, and Tourism and Recreation, and charged the newly created Smart Growth Secretariat with coordinating Smart Growth-related programs throughout the province.

The fact that each of the GLFA states and provinces has either enacted or is moving to enact *Smart Growth* reforms should be enough to motivate the forestry community to become more involved in *Smart Growth* planning at the state and local level. After all, *Smart Growth* is primarily concerned with the reform of land use planning, and forests represent the single largest land use in the Great Lakes region. As key stakeholders in the land use debate, it is imperative that the forestry community, which has heretofore had limited involvement with land planning and development policy, find a place for itself at the *Smart Growth* table. In this regard, the multiple successes of the agricultural community should represent a motivating example. The early involvement of agricultural groups in the *Smart Growth* movement has placed both farmland preservation and the right to farm movement squarely in the middle of the *Smart Growth* agenda, resulting in significant new farmland preservation programs and important changes to property tax structures such as Wisconsin's use-value assessment system.

A quick review of some of the most pressing issues facing forests and forestry in coming years illuminates the fact that the tools of *Smart Growth* could be used with great effect to protect the vitality of forests and the forest products industry in the Great Lakes region. Low density suburban development, or sprawl, which is the primary enemy of the *Smart Growth* movement, is also the single most important cause of forest fragmentation, threatening both forest ecosystems and the long-term viability of the forest products industry. *Smart Growth's* focus on maintaining healthy rural communities by supporting opportunities for local employment could also mean greater regulatory and program support for the region's widely distributed network of primary and secondary forest product manufacturers. At their cores, both the sustainable forestry and *Smart Growth* movements are concerned with providing for the ecological, economic, and social needs of the present, while assuring the preservation of adequate resources for the use of future generations. Given this shared focus on sustainability, we would argue that it is time for the forestry community to make common cause with the advocates of *Smart Growth*.

To that end, the forestry community can, and should, become involved in *Smart Growth* planning and policy-making at multiple levels. On a statewide or provincial scale, the forestry community of the Great Lakes region can look to the State of Oregon, where foresters have succeeded in incorporating forests and forestry

[2] Dawson Bell, "Granholm Panel to Study Land Use, Preservation," Detroit Free Press, January 9, 2003 (Quoting Governor's Spokesperson Mary Detloff)

[3] Sustainable Development Act of 1996, Laws of Minnesota, Ch. 454

into their state's Statewide Planning Goals and Guidelines. Oregon's fourth Statewide Planning Goal calls for the creation of programs and policies that,

...conserve forest lands by maintaining the forest land base and protect the state's forest economy by making possible economically efficient forest practices that assure the continuous growing and harvesting of forest tree species as the leading use on forest land consistent with sound management of soil, air, water, and fish and wildlife resources, and provide for recreational opportunities and agriculture.[4]

While much of the discussion swirling around Smart Growth is currently occurring at the state or provincial level and state or provincial law provides the framework for local planning, nearly all important land use decisions are made by local jurisdictions. In the future, the forestry community may also need to place an increased emphasis on involvement in local land use planning. In an informative article recently published in the *Journal of Forestry*,[5] Dylan Jenkins and Dan Goerlich support the idea that foresters should become more involved in local land use planning. According to Jenkins and Goerlich, "the world is run by those who show up," and "foresters have a competitive advantage in local land use planning processes- (they) perform land use planning and management activities for a living."

Conclusion

The *Smart Growth* and sustainable forestry movements share a commitment to the long-term sustainability of our environmental, economic, and social resources. Because the two movements share key principles and because the *Smart Growth* movement has had, and will probably continue to have, success changing the shape of land use and land use planning in the Great Lakes region in coming years, it is imperative that the forestry community work proactively to make a place for itself at the *Smart Growth* table.

[4] Oregon Administrative Rules 660-015-0000(4)

[5] Dylan H. Jenkins and Dan Goerlich, "Local Land Use Planning: How to Make a Difference," Journal of Forestry 101, No.1 (January/February 2003): 5-6.

Notes

Understanding Differences in Urban vs. Rural Perspectives on Forests, Wildlife, and Management Practices

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Introduction

The economy of Michigan's Central Upper Peninsula (UP) is primarily supported by forest products and recreation-based industries. Forest management in this area involves tradeoffs between the resources that contribute to these industries. For example, there are concerns that high deer densities are affecting regeneration of commercially valuable tree species and that logging practices affect the ecosystem functions of forests. The deer population can affect the structure and function of the forest, and it may also affect the habitat of other wildlife by adversely affecting the regeneration of certain tree species. This may disturb the habitat of other animals, such as certain species of songbirds. Forest management decisions can affect the ecosystem services provided by the forest by changing the structure and species composition of the forest. These are just a few examples of the many linkages between the goals of forest management, forest services, and wildlife. This research uses qualitative methods to determine the extent of public awareness and understanding of these interactions.

Results from focus group discussions reveal differences between urban and rural residents of the Central UP in public perceptions of forest management, forest services, and wildlife. The discussions explored opinions of and concerns for the interactions between these factors. Focus groups held in November 2002 in Michigan's Central UP were stratified to represent both urban (Marquette) and rural areas (Felch). The discussions explored public views, values, and knowledge of interactions between forests, wildlife, and management practices. Overall, an important objective was to discover whether individuals who live in this area recognize and understand these linkages and whether they are concerned about their effects.

Methods

The primary goal established for the focus groups was to gain information about public preferences for deer and forest management in Michigan's Central Upper Peninsula. This research hypothesizes that public perceptions of the tradeoffs between forest management objectives, forest services, and forest ecosystems differ between demographic groups. Specific objectives were to: (1) identify forest ecosystem services recognized by the public; (2) explore public knowledge and opinions of deer and forest management practices; (3) learn about public opinions and perceptions of the effects of forest management on forest services, deer, and other wildlife; and (4) explore opinions and perceptions of the effects of deer on forest services and other wildlife.

The focus groups were formed by randomly recruiting residents of the Marquette and the Felch areas, Michigan, by phone to form the urban and rural groups, respectively. Eight out of 15 individuals recruited participated in each discussion group. The discussions lasted approximately 1 ½ hours, with the moderator posing questions pertaining to the specific objectives of the research. On average, participants of the 2 groups had similar income and education while participants in the rural groups were older, owned more land, and lived in the UP and in Michigan for longer.

Buse, L.J. and A.H. Perera (comp.). 2003. Meeting emerging ecological, economic, and social challenges in the Great Lakes region. Popular summaries. Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. For. Res. Inf. Pap. No. 155.

The discussion groups were transcribed and analyzed for content. The transcripts were organized according to the themes of the discussion defined in the script used by the moderator. The themes of the discussions were organized as follows: forest services, forest management, forest land ownership, wildlife, and deer. Comments made by participants were organized into theme groups to illustrate similarities and differences between the urban and rural discussions.

Discussion

The results of these discussion groups suggest that there is a substantial difference between the urban and rural groups in the understanding of and concern for economic, ecological, and social effects of forest management actions. Although it is difficult to extend this generalization to the entire population of the Central UP because of the small sample size, it does tell us that there are potential differences between urban and rural perceptions in the area. This will be explored further as we conduct additional focus groups and interviews during spring and summer of 2003.

Certain aspects of the discussions exhibited similarities between the two groups. For example, residents of both areas have a strong appreciation for the natural beauty, wildlife, and scenic character of the forests of the Central UP. Concern for the welfare of future generations was expressed in both groups. Most members of both groups were aware of the effects of deer browse on tree regeneration, and both groups had some difficulty in comprehending how deer activities could negatively affect the quality of habitat for other wildlife. Participants in both groups were most familiar with the forest harvesting practices of clearcutting and selective cutting. However, the rural group displayed a more acute understanding of and concern for the effects of management decisions on forest services.

Content analysis of the discussion group transcripts reveals a high level of knowledge of forest management practices and an impressive understanding of forest-wildlife-management interactions among participants in the rural group. Some of these respondents expressed a detailed understanding of timber harvest timing, rotations, equipment, financial investments, etc. The connections that link the land, residents of the region, and wildlife were brought up repeatedly by participants in the rural group, while these interactions were not mentioned as frequently in the urban group. The perception of land ownership and its effects on how forests are managed differed between the groups. Several participants in the rural group stated that private landowners are saving the forests in the region whereas corporate and public landowners are harming forest resources. In the urban group, there was agreement that private owners practice uninformed management that depletes forest resources while corporate or public land management is more beneficial for forest resource sustainability.

Concerns for the sustainability of the local economy and community were expressed very strongly by the rural group through specific references to the importance of forests for provision of recreation and tourism in the area. The importance of the forests to the regional economy was discussed only briefly in the urban group through the mention of recreation, specifically the importance of snowmobile and ATV trails as tourism draws. Rural participants recognized potentially conflicting objectives of forest management, such as providing jobs in the forest products industry versus maintaining the ecological services provided by the forests. Employment in the forest products industry emerged as a major theme in the rural group discussion, while this was not talked about much in the urban group. The rural group generally displayed a deeper understanding of and concern for the competing goals of forest management than did the members of the urban group.

Conclusions

The divergence in perceptions and knowledge of forest ecosystems, management, and economic sustainability between the two groups indicates a substantial urban-rural difference in knowledge and attitudes towards resource management among residents of the region. Understanding public perceptions can help managers develop strategies to connect management regimes to publicly acceptable ecosystem outcomes. The level of concern about the effects of tradeoffs between managing forests for ecosystem services and managing for forest products differs greatly between the urban and rural groups. The information gained from these discussion groups helps us understand public perceptions of the role of public and private landowners in providing socially optimal levels of forest products and services.

Notes

Integrating Indicators of Forest Health into a Comprehensive Great Lakes Suite

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The governments of Canada and the United States have obligations under the Great Lakes Water Quality Agreement to periodically report on environmental conditions in the Great Lakes basin. In response, the biennial State of the Lakes Ecosystem Conferences (SOLEC) were established in 1994 to provide one of the reporting venues. To provide a framework for consistent reporting, a series of indicators have been developed and are being used to assess the status and trends of Great Lakes ecosystem components. Groupings of the indicators currently include near- and offshore waters, coastal wetlands, near-shore terrestrial, watershed, human health, societal, and unbounded (e.g., acid precipitation and climate change). Information is provided not only on the state of environmental components, but also on the pressures being exerted on the ecosystem and the human responses to mitigate those pressures. For SOLEC 2002, indicators for the influence of forests on water quality in the Great Lakes basin were proposed for inclusion in the comprehensive suite within the watershed category. These indicators are currently being further evaluated, and when they are reported, they will be expected to provide information critical to the overall assessment of ecosystem health in the Great Lakes basin. SOLEC organizers are grateful for, and rely on, the cooperation and collaboration of partner agencies and organizations throughout the Great Lakes basin for their contributions to the assessment of the Great Lakes conditions.

Buse, L.J. and A.H. Perera (comp.). 2003. Meeting emerging ecological, economic, and social challenges in the Great Lakes region: Popular summaries. Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. For. Res. Inf. Pap. No. 155.

Notes

A Review and Synthesis of Selection Factors for Indicators of Forest Sustainability

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At any scale of geographic application, the process for identifying indicators of forest sustainability for Criteria and Indicators Processes is normally accommodated by listing a set of subjective factors to review proposals against. Based on experience gained from reporting on Montreal Process Criteria and Indicators at the management unit, provincial, and national scales, and a need to rationalize indicator suites post-report for future reporting, the Lake Abitibi Model Forest has led an effort to synthesize indicator review factors. Literature was reviewed to identify the range of factors generally considered. A synthesis of the factors considered has been compiled with associated definitions. Common concepts were identified for grouping review factors across the various implementations. Definitions for each indicator review concept were derived and are proposed for general usage.

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Notes

Relationships Between Housing Density and Timber Harvest in the Upper Lake States

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Introduction

Natural resource managers throughout the United States frequently cite the increasing proximity of forestland to human development as a growing concern (Wear et al. 1996, Riemann and Tillman 1999). The expansion of urban areas, suburban development, and the influx of residential and recreational development into previously forested areas may reduce the amount of forest interior habitat, exacerbate the invasion of exotic species (Theobald et al. 1997), limit the range of management practices that can be used (Cubbage et al. 1995, Wear et al. 1999), and alter the structure of native vegetation (Riemann and Tillman 1999).

Non-metropolitan areas throughout the U.S. Midwest are undergoing significant increases in housing growth rates. Such rural sprawl is especially prominent in areas with attractive recreational and aesthetic amenities (Radeloff et al. 2001, Hammer et al. 2003). In the Upper Great Lakes, many summer-oriented recreational counties rate 30-50% of all housing units as seasonal-use dwellings (Beale and Johnson 1998). While each single new house causes negligible effects, the accumulation of these individual changes over time and within a landscape or region may constitute a major impact (Theobald et al. 1997). Housing change may affect timber harvest when forest area declines due to deforestation and when management practices on the remaining forests are altered in response to a changing social context (Hull and Stewart 2002).

Prior research has indicated that timber-harvesting rates may be closely related to human population density (Barlow et al. 1998, Dennis 1989, 1990, Wear et al. 1999). However, by using population density as a predictive variable these studies do not consider the possible effects of seasonal homes, which increase housing density without corollary increases in population density. Solid assessments of these effects are thus critical to predicting future timber production and sustainable harvest levels. Here, we examine the relationship between housing density and forest basal area, removals, and mortality in Michigan, Minnesota, and Wisconsin.

Approach

Forest Inventory and Analysis (FIA) data from the 1990 Minnesota, 1993 Michigan, and 1996 Wisconsin inventory cycles provided information on timber removals, basal area, and mortality rates (Hahn and Hansen 1985). Decennial U.S. census data were used to calculate housing density at the partial block group level (see Hammer et al. 2001, Radeloff et al. 2001).

Using ArcGIS, we calculated housing densities within 1-km buffers placed around each FIA plot. Scatterplots, logistic regression, and analysis of variance (ANOVA) were then used to examine the relationships between housing density and timber removals, standing basal area, and mortality. Variables included in logistic regressions and ANOVAs were considered significant at the $p=0.05$ level. Prior to performing these analyses, the data were transformed if necessary to ensure that statistical assumptions were met.

Results and Discussion

Scatterplots comparing volume of timber harvest to housing density within a 1-km radius indicated a strong negative relationship between these two variables. About 90% of all harvest events occurred at housing densities below 5.5

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houses per km² in aspen, 10.3 houses per km² in maple/beech/birch, 10.8 houses per km² in jack pine, 12.0 houses per km² in red pine, and 16.8 houses per km² in oak-hickory forests (Figure 1). Timber harvests generally occurred at lower housing densities in pine and aspen forests compared to hardwood stands. Regression of log harvest against log housing density indicated that housing density was significant at $p = 0.002$.

The relationship between housing density and timber harvest also varied across ecological subsections. For example, in subsections that contained 100 or more maple/beech/birch plots, the housing density below which 90% of harvest events occurred varied from fewer than 5 houses per km² to nearly 30 houses per km² (Figure 2). A general linear model fitted to these data indicated that not only was log housing density significant, but ecological subsection, forest type, and interaction between housing density and forest type were all significant at $p \leq 0.02$ (Table 1).

Scatterplots indicated possible negative relationships between housing density and both basal area and mortality. When linear models were fitted to these data, log housing density, ecological subsection, forest type, and interactions between ecological subsection and both forest type and housing density were significantly related to log mortality at $p \leq 0.03$ (Table 1). Housing density was not significantly related to standing basal area alone, but ecological subsection, forest type, and interactions between ecological subsection, and both forest type and housing and housing

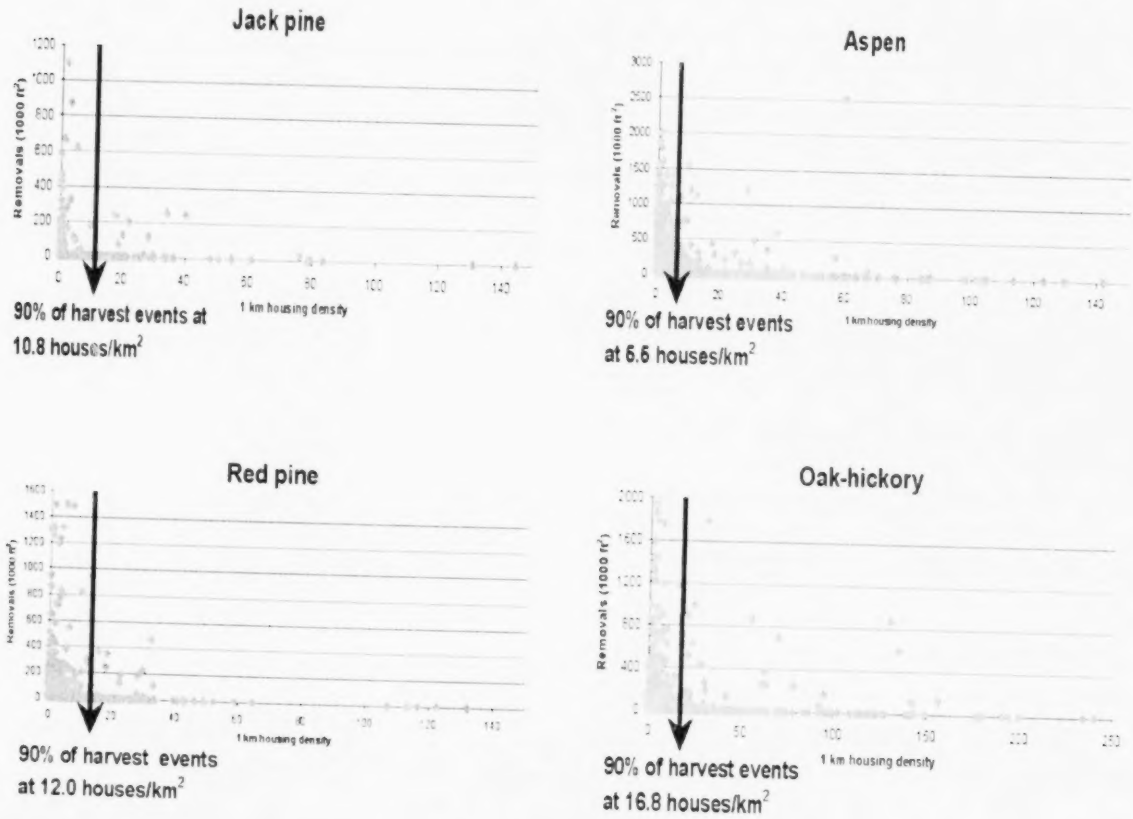

Figure 1. *Timber removals versus 1-km housing density for four forest types in the Upper Lakes States.*

Table 1. *P-values for linear models of harvest, mortality, and basal area.*

	Log Housing Density (HD)	Ecological Subsection (ES)	Forest Type (FT)	FT*ES	FT*HD	HD*ES
Log Harvest	0.023	0.003	0.014	ns	0.015	ns
Log Mortality	0.03	< 0.0001	< 0.0001	< 0.0001	ns	0.004
Log Basal Area	ns	< 0.0001	< 0.0001	< 0.0001	ns	< 0.0001

density were significantly related to log basal area at $p < 0.0001$ (Table 1).

Conclusions

Harvesting rates are closely related to housing density, even in sparsely populated areas. This may be due to negative public attitudes towards silvicultural treatments, ownership fragmentation, or changing management objectives. Our analyses indicated the importance of controlling for ecological subsection and forest type when analyzing the effects of housing density on timber harvest. Similarly, housing density, ecological subsection, and forest type all significantly affect mortality. These results suggest the Upper Lakes States may experience substantial decreases in timber harvest if housing density continues to increase in the future.

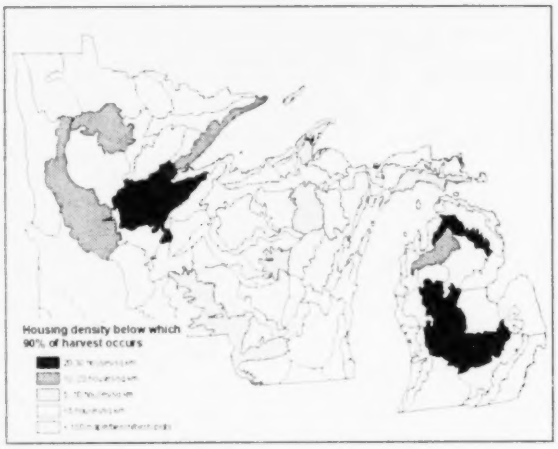

Figure 2. *Housing densities below which 90% of maple/beech/birch harvests occurred, by ecological subsection.*

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Notes

Seventy Years of Forest Change in the Northern Great Lakes Region, USA

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Introduction

The rates and magnitudes of forest change have important social and economic implications. We address facets of change associated with 20th century recovery of the U.S. Lake States (Michigan, Wisconsin, and Minnesota) forests from the Great Cutover, and discuss ecological and socioeconomic implications for future forest resources.

Between 1820 and 1920, logging and subsequent slash fires greatly altered the composition and structure of the U.S. Lakes States forests. Old growth forests dominated by a mixture of conifers and hardwoods were largely replaced by the early successional hardwood species of quaking aspen (*Populus tremuloides* Michx.), bigtooth aspen (*P. grandidentata* Michx.), and paper birch (*Betula papyrifera* Marsh.). Between 1940 and the present, abundant aspen fueled the growth of an extensive pulp and paper industry in the region. Wisconsin topped the nation in paper production for the 47th year in a row in 2002. Forests of the 21st Century are likely to look much different than those of the past; however, as natural succession, fire suppression, harvesting, herbivory, insects, pathogens, and climate change create different conditions at local and regional scales. Extensive social pressure exists to manage these forests for both early successional and old growth characteristics.

We use historical forest survey and timber utilization data to quantify changes in the composition and structure of the Lake States forests. Our specific study hypothesis is that the Lake States forests are in a period of rapid transition, as the early successional aspen-birch forests established during the Great Cutover mature and shift to later successional types. Evidence in support of this hypothesis comes from National Forests within the region, which have lost aspen acreage in recent years despite attempts to maintain it.

Approach

Data on forest composition and structure are derived from the USDA Forest Service Forest Inventory and Analysis (FIA) survey. Digital versions of the full FIA datasets date back to the late 1970s and early 1980s in the region (survey cycles 4, 5, and 6); paper summaries are available through the mid-1930s (survey cycles 1, 2, and 3). Although the overall purpose of the survey, to inventory of forests conditions, has remained consistent, changes in sampling methodology over time limits the level of detail accessible in cross-cycle analysis.

We use data on pulpwood production to address socioeconomic facets of forest change. Summaries are available in the form of timber product output reports, compiled timber receipts furnished by pulp mills between 1946 and 1998.

Results and Discussion

In Michigan and Wisconsin, the dominant trend in the FIA data is a gradual transition from young forests dominated by early successional aspen-birch to late successional maple-beech-birch (primarily sugar maple, *Acer saccharum* Marsh.; Figure 1a,b). The bulk of these shifts occurred between the 1950s and 1980s, and recent trends show slower rates of change. In contrast, the extent of aspen-birch has remained stable in Minnesota since the 1930s (Figure 1c). Although much of Minnesota has witnessed a slight

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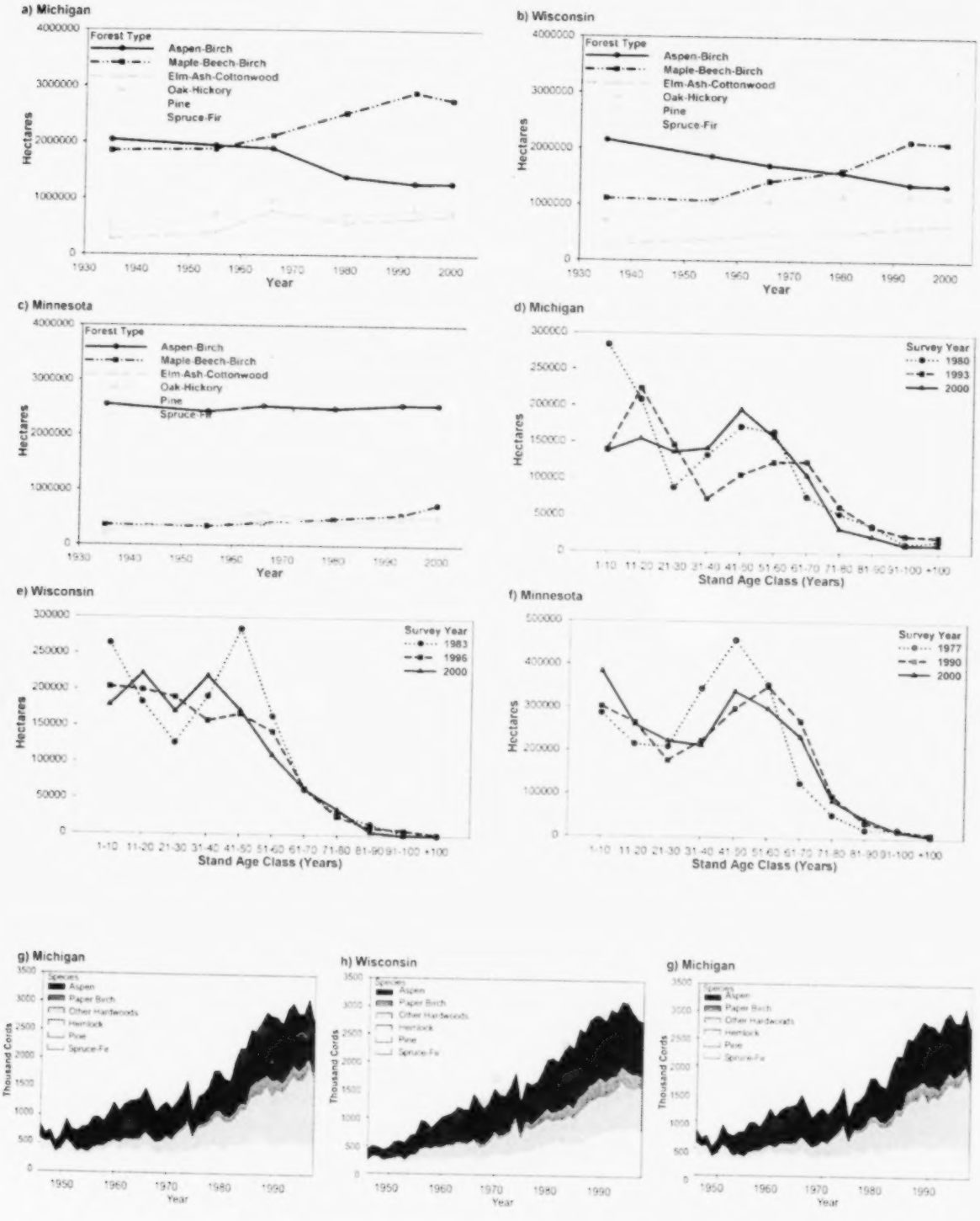

Figure 1. *Trends in forest type extent (a-c), aspen-birch stand age (d-f), and pulpwood production (g-i) for the U.S. Lake States.*

increase in the amount of maple-beech-birch forest, conversions are split between aspen-birch, elm-ash-cottonwood, and oak-hickory types. Pine forests constitute a minor forest type in all three states; however, the region has seen a two- (Minnesota) to 12-fold (Michigan) increase in the extent of red pine (*Pinus resinosa* Ait.) between the 1930s and the present. White pine (*P. strobus* L.) has also increased in Michigan and Wisconsin, though less dramatically, and jack pine (*P. banksiana* Lamb.) acreage has been lost from all 3 states. All states have also seen a gradual decline in the extent of the spruce-fir forest type (Figure 1a-c). Although the direction and rate of change varies among ecosystems and ownerships, tree volume across the region has nearly doubled over the survey period. Barring aspen on federal lands, growth in the 1990s continued to exceed harvest for nearly all forest types and ownerships.

Age structure data from the last 3 FIA survey cycles reveal a region still dominated by young forests. Most stands are between 30 and60 years of age, and few forests greater than 100 years old exist (11.8%, 7.2%, and 5.3% of forestlands in Michigan, Wisconsin, and Minnesota, respectively). Aspen-birch forests are dominated by young stands (1 to 60 years), and intensive harvesting is eliminating the marked bimodal age distribution present during the fourth survey cycle. Few stands reach older age classes (>80 years; Figure 1d-f), especially in Wisconsin (Figure 1e), at which time conversion to other forest types occur. Age structure data corroborate compositional data in suggesting a continuation of current cover type trends for sometime to come.

Rates of forest utilization as measured by pulpwood production have tripled in the U.S. Lake States (Figure 1g-i). Data from Wisconsin show near linear increases between the mid-1940s and early 1990s, whereas pulpwood industries in Minnesota developed much later. Recent trends suggest stabilization of aspen use by industry. Rather, producers in Michigan and Wisconsin have recently shifted to using maple-beech-birch, concomitant with its increased availability on the landscape (Figure 1g,h).

Conclusions

Michigan, Wisconsin, and Minnesota have unique patterns in forest succession and utilization between the 1930s and today – it is difficult to generalize across the region. As expected, the extent of late successional maple-beech-birch forest is increasing throughout the Lake States, but:

- In Michigan and Wisconsin, most shifts between aspen-birch and maple-beech birch occurred between the 1950s and 1990s; current changes in composition and structure are occurring at much slower rates.
- In Minnesota, the extent of aspen-birch far exceeds that of all other forest types and shows stability over time. The acreage of maple-beech-birch has increased only slightly here.

These trends suggest that the U.S. Lake States forests may be shifting from a period of recovery, in response to the Great Cutover, to a period of intensive management and utilization, with continued hardwood dominance of the landscape. Harvesting aspen-birch via traditional clearcutting methods and maple-beech-birch through group selection will likely maintain these forest types through time, with few opportunities for other species mixtures. Though beneficial from an operations standpoint, a more constant composition and structure in the region could present many ecological and socioeconomic challenges in the future, including:

- Although forest industry has adapted to the influx of maple-beech-birch, the ramifications on regional forest productivity of conversion of fast growing aspen to slow growing maple may not yet be realized. This factor may be offset by a focus on wood quality.
- Few opportunities exist to shift the forest to valuable softwood species via natural regeneration and selection-based silviculture. Restoration of conifers will likely be slow and expensive.
- Forests of uniform composition and structure lack ecological resilience and do not weather the trials of insects, disease, or climate change well. The socioeconomic impact of a lack of ecological resilience can be substantial.

Notes

The Emerging Challenge of Values Elicitation and Utilization in Forest Planning and Management

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Because people are a part of ecosystems, Manitoba's Forest Plan asserts that:

> *People's values are one cornerstone of ecosystems based management of forests. Understanding the values associated with the states (e.g.,roadless wilderness), services (e.g., carbon sequestration and water filtration) and goods (e.g., timber, blueberries, and game) produced by the forests is a prerequisite to defining and implementing management practices* (KPMG, 1996: I-4).

However, little detail is presented as to how to do this; much more space is devoted to the task of characterizing ecosystems and forest data. As ecosystem based management (EBM) matures, a more sophisticated understanding of values and an array of methods for eliciting, analysing and incorporating values in management will be required. This presentation attempts to redress the imbalance by presenting the results from a province-wide survey in which a value scale and an attitude inventory were used to elicit forest-related values and attitudes toward management from a sample (n=710) of Manitobans. Reported here are selected results under two headings: Manitobans' values and lessons for forest managers.

Manitoban's Values

Among the "value scales" employed in the survey was a Forest Values Scale (C-Scale) which evoked values people hold about forests and their uses and a Forest Management Scale (F-Scale) which identified attitudes about forest management issues in Ecoregion 90. This presentation reports results from the C-Scale and F-Scale. For these scales, respondents rate basic statements on a 5-point scale, ranging from "strongly disagree" to "strongly agree", with a "don't know" option as well.

Forest Values: C-Scale

To assess value orientations about forests, respondents were asked to indicate their level of agreement with 15 statements concerning various aspects of forests and their potential uses.

The percentage distribution for the Forest Values Scale (C-Scale) reveals 2 very strong responses: 84% of respondents "strongly agree" with the existence value expressed by item C1 "Whether or not I get to visit the forest, it is important to know that forests exist in Manitoba." And 81% "strongly agree" with the bequest value expressed by item C10: "It is important to maintain our forests so that future generations will enjoy the same benefits that we enjoy." Clearly most respondents want to preserve forests and pass them on intact as part of a legacy for future generations.

The neutral third rank received the highest proportion of choices, 27%, only in the case of C5 "As many uses should be made of forested public land as possible." This statement also achieved one of the highest levels of "don't know" at 8%. In other words, they might be indicating that it depends on the type of uses proposed.

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The forest value items were also ranked by the percentage of respondents strongly agreeing with the statements. The percentages range from a high of 84% for item C1 (see above) and a low of 5% for item C7 "Forests should be used primarily for timber, wood, and paper products." Closer examination reveals that the 8 top-ranked items are biocentric in orientation, agreeing with spiritual and existence values and the rights of forests and other species to exist for their own sake, and the 5 bottom-ranked items are human-centred. Although most, 9 of the 15, items emanate from the biocentric perspective, the definite split in ranking in the direction of biocentrism among these respondents is noteworthy.

Forest Management Scale: F-Scale

The Forest Management Scale, or F-Scale, is an attitude survey about forest management issues in Ecoregion 90. The goal was to obtain information about specific issues in the context that actually exists in the ecoregion.

Nine of the 19 scale items have a predominantly economic orientation and the remainder an environment orientation. All of the items were chosen because their subject matter was relevant to issues under discussion in Ecoregion 90. It was important to see what the response of the public was to these items.

The percentage distribution of responses about views on forest management was examined. The largest single response of 65% who "strongly agree" that "Forests should be managed to ensure healthy populations of all wild species of trees, other plants, animals, and other living things" again reflects a strong existence value for wildlife and natural landscapes. The "don't know" is one of the lowest in the table and the "agree" factor totals 89% if we sum level 4 and level 5. The "disagree" factor totals 3 percent if we sum level 1 and level 2. Another example of existence values again being displayed occurs in item F19: "Recreation activities should be restricted to limit their effects on ecosystems and wildlife." This statement achieved a total agreement level of 64%, split evenly between "strongly agree" and "agree." Eleven percent disagreed.

Protection, or advancement, of the forest industry at a cost to the ecosystem is not acceptable, based on the responses shown. In item F15: "Tree harvesting methods should maximize economic returns regardless of their impact on other of forest values and uses," 53% of respondents "strongly disagreed" while another 24% "disagreed" for a total of 77%. Similarly in item F5, "Survival of the forest industry and possible expansion of jobs are more important than preservation of wilderness in Ecoregion 90," 38% "strongly disagreed" and 31% "disagreed" totalling 69% in disagreement. On the other hand, sustainable forest management is endorsed in the response to item F11: "Logging forests is acceptable if it does not cause permanent damage." The overall agreement level with the statement was 61% including a "strongly agree" level of 23%.

These value items were also ranked by the percentage of respondents strongly agreeing with the statements. The percentages range from a high of 65% for item F6 (above) to a low of 3% for item F5: "Survival of the forest industry and the possible expansion of jobs are more important than preservation of wilderness in ER90." Closer examination reveals that the top-ranked 9 items are environmental in orientation and the bottom-ranked 10 items are economic, except for F10: "The forests and landscapes of ER90 should be managed by the communities they surround," which is labelled environmental but really has a social orientation.

Implications of the Results for Resource Managers

The *Ecosystem and Forest Values Survey* provides an opportunity to identify values of a broad-based sample of Manitobans as of January-February 2000. Given the size of the sample (710 respondents), the results can be interpreted as those of a "typical Manitoban." These results provide guidance to resource managers currently

grappling with critical issues and the increasing demands of publicly accountable decision-making.

The preliminary analysis of forest values (C-Scale) and attitudes toward forest management (F-Scale) indicate that Manitobans are interested in and concerned about the environment, nature, and ecosystems. Common themes seem to be the importance of maintaining wilderness and natural forested ecosystems and providing a range of habitats for plants and animals including people as traditional resource users. The economic development potential of Ecoregion 90 via industrial resource development (forestry, mining, and hydro-electric) did not rate highly with Manitobans. In the analysis of these value scales, Manitobans show biocentric or environmental orientations on general ecosystem issues and forest ecosystem management issues. These orientations appear more strongly than the human-centred or economic alternatives. Manitobans also endorse management strategies that encompass broad ecosystem issues rather than focussing on individual components of the ecosystem.

More specifically, analysis of the results from C-Scale on forest values and F-Scale on attitudes about forest management contain several points that should be of paramount interest for resource managers. In summary, resource managers should take into account the following forest values and management attitudes expressed by Manitobans:

1. Forests are a revered feature for Manitobans even though Manitoba is thought of as a 'prairie province'. (C1)
2. Expansion of timber harvest is not a high priority with Manitobans. (C9, C7)
3. Industrial use of forests or forest land should be done with care and consideration, almost with reverence. (C12, C6, C3)
4. Forests, and the plants and animals that live there, are important to Manitobans in their own right. They have intrinsic value. (C15, C13, C2, C11)
5. Ecosystem based management is strongly endorsed. (F6, F13, F12)
6. Roads should be minimized and the area substantially preserved as wilderness. (F7, F18, F19)
7. Additional protected areas should be created and existing ones preserved even at the cost of forest industry jobs and profits. (F4, F8, F9, F5)

Conclusion

Ecosystems Based Management calls on participants in the planning process to become familiar with value phenomena and the expanding range of options for values elicitation. The values team concluded that "there is no simple cookbook for grabbing people's values and plugging them into a plan" (Fenton et al., 2001: V-10). However, we remain convinced that an awareness of values information and values elicitation techniques, like those presented in this paper, can contribute to planning and management that reconciles citizen expectations and ecological capacity.

Notes

Ontario's Forestry Research Partnership: Knowledge Transfer and Outreach for Sustainable Forestry

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Introduction

The Forestry Research Partnership (FRP) comprises industry, provincial and federal governments, and a non-government environmental education organization. Beginning in the spring of 2000, the FRP assembled a package of research, transfer, and education activities aimed at increasing the wood supply to Tembec mills, while addressing environmental concerns. Part of the package is aimed at using intensive forest management to increase fibre production on Crown lands designated for use by forest industry. It is a practice that is provided for in the Ontario Forest Accord, a key component of Ontario's Living Legacy strategy. The Accord enables the establishment of new protected wilderness areas and parks while considering the needs of the forest industry for a sustainable wood supply. This paper focuses specifically on FRP transfer and outreach activities and their contributions to the partnership's main objective.

First Things First – A Defining Objective

In forging the partnership, a small team of Ontario Ministry of Natural Resources (OMNR) and Canadian Forest Service (CFS) representatives worked with Tembec's Manager of Forestry Research and Development to obtain a clear statement of purpose from Tembec. The company was committing substantial financial resources to the partnership and it was important to all partners that the purpose be clear. The result was a 10-in-10 objective – an increase in the sustainable annual allowable cut across Tembec forest licenses in Ontario by 10% within 10 years. With the objective defined, the first projects were identified and developed, the stage was set for subsequent work, and the trap of trying to support many disconnected projects was averted from the outset.

Building 'Ready-to-Use' Transfer and Outreach Capabilities

From its inception, the FRP emphasized the importance of technology transfer (TT). Within 7 months, a full-time TT coordinator was hired, and 2 internship positions were filled to provide ongoing support. This core capacity has leveraged considerable expertise and in-kind resources from the partners. To date, transfer products include 10 workshops (attendance 480), 8 field tours (attendance 200), 4 science seminars (attendance 175), and a variety of training sessions, demonstrations, and planning meetings. The TT team has established a track record for promptly distributing follow-up products to participants and has assembled a product catalogue on the FRP web site (http://forestresearch.canadianecology.ca/). The web site itself is a dynamic information sharing and distribution vehicle.

Bringing Knowledge to Ground – The 'Core Team' Approach

Towards the 10-in-10 objective, the FRP intensively attempted to engage clients in the forest management units. This is the working level at which decisions are made about where, when, and how to conduct stand-level

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treatments. Forest management plans target quantified annual wood supply balanced with targets for forest health and ecosystem sustainability. In what was considered a pilot approach, the FRP established teams for 3 Tembec forest management units: Romeo Malette, Gordon Cosens, and Nipissing. The 'core teams,' as they soon became known, comprised local OMNR and Tembec forest management and operations staff, and received input and guidance from the FRP Secretariat and from specific FRP project leads. The FRP TT team provided a coordination and facilitation role, ensuring the core teams met scheduled milestones.

Each core team was charged with reviewing intensive forest management options for achieving 10-in-10. To this end, the teams soon directed their attention to the use of forest-level models to help in the assessment of various options and their effects on allowable harvest levels. A forest modeller was assigned to each team. Different intensities of management were modelled, from natural, through extensive, basic, intensive, and elite. Improved growth and yield data were entered in the models, thereby improving forecasted wood supply under different treatment regimes. Commercial thinning, not a recommended silvicultural treatment in Ontario's boreal forest, was evaluated and found to be an option worth considering on all 3 units.

Responding to Local Needs and Stimulating Demand for FRP Products

At the May 2002 Intensive Forest Management Implementation Workshop, forest managers from each core team presented the local needs and recommended options for reaching 10-in-10. Discussion and debate among all participants served to identify 'best-bet' options for each management unit. The new goal became moving ahead with the chosen options within forest management plans, and filling defined knowledge, research, and information gaps. FRP TT events and activities continued unabated. From June to November 2002, the Partnership hosted 2 general science seminars, a spatial succession rules workshop, a commercial thinning workshop, and multiple field tours.

Determined to realize the benefits of spatial modelling in achieving 10-in-10, core teams prepared to apply the Patchworks Spatial Model on each unit. Team members worked to refine the model so that it would effectively support management options such as commercial thinning, and satisfy provincial planning requirements related to forest succession rules. Additional efforts focused on the inclusion of new and updated yield curves for the standard boreal forest units, and updates to silvicultural data sets.

Field visits examined commercial thinning, including the effects of logging damage and impacts on growth and yield. While the Nipissing team focused on CT in terms of tolerant hardwood management, the Romeo Malette and Gordon Cosens teams worked on implementing operational trials that would bring about approximately 700 ha of boreal commercial thinning in 2003. Core teams continued to work towards the gradual integration of intensive forest management practices within their planning schedules and operations on their management units.

Education – Making Informed Choices for Wood Supply and Sustainable Development

The Canadian Ecology Centre (CEC), a non-profit charitable organization, brings its forest education mandate and experience to the FRP. Located within Samuel de Champlain Provincial Park on the historic Mattawa River, the Centre provides an indoor/outdoor facility and experienced educational programming staff. Drawing upon the knowledge of FRP partners, the CEC has reached audiences including students at the elementary and secondary level, forestry-related post-secondary students, teachers at all levels, and the environmentally aware

public-at-large. A showpiece among CEC's numerous educational offerings is the Northeastern Ontario Teacher's Tour, hosted in partnership with the Temperate Forest Foundation, based in Oregon. The event has enjoyed 2 successful years, and is now an annual CEC event that draws 50 teachers from Ontario, Quebec, other parts of Canada and the U.S. The result is an intensive learning experience that educates educators about forest management and the forest industry.

The FRP/CEC relationship is a formula for linking forest resources management with education curricula. It operates on the premise that sustaining our forest industry, our communities, and the forests requires an educated and informed cadre of young people – the managers and educators of tomorrow - who understand the issues and the science behind extraction and reforestation.

FRP's Role – An International Perspective

The FRP has demonstrated that TT and outreach specialists have much to gain by working cooperatively across organizations and borders. In 2002, the FRP sponsored a visit to Ontario by Paul Oester, Extension Forester with Oregon State University's County Extension Service. Over a 9-week period, Mr. Oester visited various forest management and research facilities, and field sites, and met with dozens of people to gain a sense of how Ontario is approaching the challenges of transferring knowledge into forest management practice. Clearly there is opportunity to increase networking among TT professionals; our shared interests in tools and best practices are more significant than differences presented by organizations or jurisdictions. The FRP aims to realize the potential of Canada-U.S. cooperation, through future visits and exchanges.

Conclusion

With the commitment of financial and in-kind resources, partner organizations have devoted people and brought existing knowledge to bear on achieving the core FRP objective. Managers and staff in partner organizations are supporting the thoughtful ordering of projects and insisting on effective linkages among projects, without which the partnership could not be as effective or successful. The FRP TT team is facilitating linkages and strengthening relationships among researchers, developers, and practitioners and encouraging all to work together to advance practice. Outreach and education is drawing upon FRP expertise to help the next generation of resource managers make informed decisions about wood supply and sustainable development. International cooperation is 'sharpening the saw', and helping to advance professional TT and outreach practices in Ontario and beyond.

Notes

Corporate Sustainability in the Form of Social Responsibility Policy

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Stora Enso is one of the largest producers of paper and paperboard in the world. Stora Enso operates in 40 different countries and uses 44 million m^3 under bark per year of wood in its operations. Traditionally, businesses have focused on the financial segment of the business. This was followed by a focus on the environmental issues primarily in forest products industries. As a global forest products company, Stora Enso recognized the importance of its relationship to society and in 2001 developed a Corporate Social Responsibility (CSR) policy. The goal of this session will be to present the specific components of the policy and how Stora Enso is integrating these principles into practice. The Stora Enso Environmental and Social Policy and Principles of Corporate Social Responsibility are as follows:

Environmental and Social Policy

Responsible business

Stora Enso is committed to developing its business towards ecological, social, and economic sustainability. These tasks are recognized as shared responsibilities within Stora Enso enabling a continuous improvement of our operations.

Eco-perspective

Stora Enso's objective is to supply customers with products and services that satisfy various needs related to printed communication, packaging, and construction purposes. These products are mainly produced from renewable raw materials, and are recyclable and safe to use. The concept of product life cycle guides our environmental activities and provides the framework for our efforts. We expect the same commitment from our suppliers and partners so that at every stage, from raw material to the end product, the impact on the environment will be minimized.

Social respect

As an international company, Stora Enso acknowledges its role as a model company in the global, national and local society. Our attitude shall be characterized by respect for the cultures, customs and values of individuals and groups in countries where we operate. When developing our business to earn credibility, we will comply with and when necessary go beyond the requirements of national standards and legislation.

Transparent interaction

In order to continuously strengthen our operations and develop environmental and social issues in a sustainable way, Stora Enso considers an open discussion and interaction with all stakeholders, both governmental and non-governmental, as fundamental.

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Stora Enso Principles of Corporate Social Responsibility

Business Practice

- Cooperation between Stora Enso and our stakeholders shall be open-minded, fair and based on equal terms.
- Practices defined as bribes, kickbacks, price-fixing and similar behaviour are prohibited.
- Employees must avoid conflicts of interest between their private financial activities and the conduct of company business.
- All business transactions on behalf of Stora Enso must be reflected accurately and fairly in the accounts of the company.

Communication

Communication is based on credibility, responsibility, pro-activity and interaction. These apply equally to all stakeholders. We advocate an open dialogue.

Community Involvement

We shall be a responsible member of the communities in which we operate through focused partnerships at local, national, and global levels. We encourage our employees to take part in local community work.

Reduction in Workforce

Any reduction necessary in the workforce shall be carried out with respect for the individual and proper sensitivity to employees' needs.

We support the UN's Universal Declaration on Human Rights and the core conventions of the International Labor Organization (ILO), from which Stora Enso has derived the following principles:

Working conditions

Our employees are entitled to safe and healthy workplaces. No employee shall be subject to any physical, psychological or sexual harassment, punishment or abuse.

Key Stakeholders

Customers

All current and potential companies and individuals that choose our company to provide goods or services to them.

Employees

All employees of the company and employees in operations controlled by the company.

Investors

All current and potential owners of our company's equity and debt.

Partners

- Suppliers.
- Co-investors and those who join us in other mutually beneficial activities.
- Trade and business associations of which we are members.

Diversity

We recognize diversity as a strength. Discrimination against any employee in respect of race, ethnic background, gender, disability, sexual orientation, religion, political opinion, maternity, social origin or similar characteristic is prohibited.

Freedom of association

Employees have the right to organize, join associations and bargain collectively, if they wish to.

Free choice of employment

Any form of involuntary labour is prohibited.

Child labor

Use of child labor is not permissible. The minimum age for employment shall be in accordance with the ILO convention (14 or 15 years) or the age specified by local legislation if higher. The employment of young persons shall not jeopardize their education or their development.

Remuneration

Wages shall be paid direct to the employees. Employees shall be paid at least the minimum

legal wage or the wage specified in an applicable collective labour agreement.

Working hours

Working hours shall not exceed 48 hours and overtime 12 hours per week on average over a year, unless other conditions are specified in local laws or an applicable collective labour agreement.

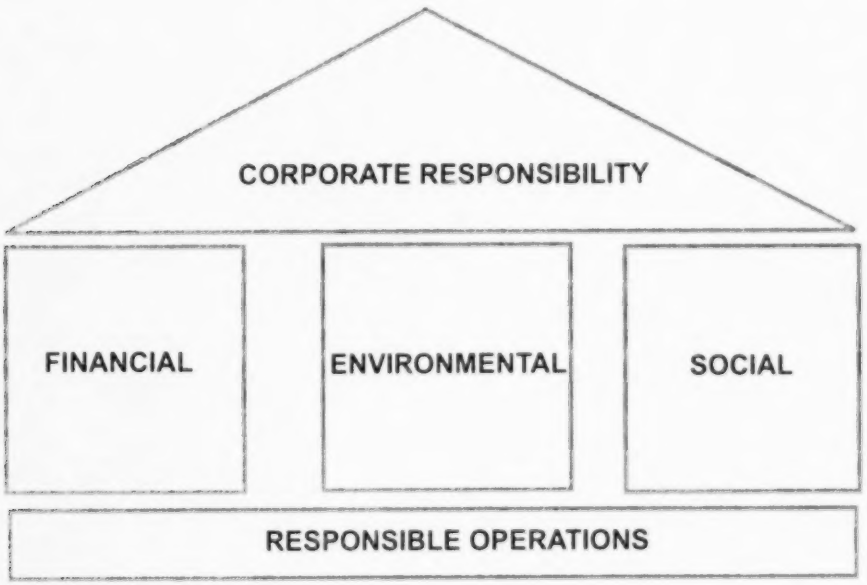
Society-Civil

The individuals in our neighbouring communities. Organizations engaged in civic and charitable work as well as non-governmental organizations.

Society – Governmental bodies and administrators

Local and national governmental bodies, administrators, politicians/ elected officials and transnational bodies such as the UN.

The figure below is a graphic that demonstrates that we cannot separate the 3 pillars — financial, environmental, and social — that support Corporate Responsibility. Our investors expect Stora Enso to have responsible operations in all aspects of our business. To do otherwise would jeopardize our ability to remain a sustainable forest products company.



Notes

Education—A Key Link in Sustaining Our Forests

Sterling H. Strathe

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Introduction/Objectives

The Great Lakes Region is blessed with a wealth of natural resources. As the first European immigrants settled this area, the forests of the Great Lakes Region provided building materials, jobs, and money for a fledgling regional economy. Today the forests of the region provide not only our basic needs, but also continue to contribute greatly to our ecological, economic, and social well-being.

At no time since the initial cutover have our forests faced greater potential challenges. On the near horizon are changes in forest ecosystems, forest demands, forest management, and forest values (the relative worth that people place on our forests). Questions about the ability of our forests to meet all of our current and future needs are apparent given these challenges and the mixed value system that our citizens place on our forests.

How we sustain our quality of life (ecologically, economically, and socially) will depend on how we sustain our forests. Sustainable forestry is evolving to address these challenges. For sustainable forestry to be successful, however, requires not only research, technology, and management, but also a citizenry that understands and backs the necessary measures needed to insure long-term sustainability.

The objectives of this presentation are to:

1. develop a rationale for the need to educate our citizens about sustainable forestry,
2. examine measures taken by the Wisconsin Department of Natural Resources' (DNR) Division of Forestry to address this issue through K-12 education, and
3. explore the process of developing and funding this endeavour.

Approach

In March of 2001, Wisconsin K-12 forestry education stakeholders met at the Wisconsin Center for Environmental Education to discuss the status of forestry education in Wisconsin K-12 schools. Although a variety of materials and providers were available, the group identified a need for an umbrella program that would support, guide, and promote forestry education in Wisconsin's K-12 schools. Cited as advantages to such a program were:

- increasing partnering between programs and projects,
- documenting the important concepts students should know about our forests,
- developing Wisconsin-based activity guides that address these concepts,
- correlating activities to Wisconsin Model Academic Standards,
- addressing professional development opportunities for teachers,
- networking of K-12 forestry education providers,
- providing incentives for teacher participation,
- developing a clearinghouse for K-12 forestry education resources,
- increasing K-12 forestry education specialists for consultation with schools, and
- increasing access to university resources.

The Wisconsin Center for Environmental Education (WCEE) submitted a proposal to the Wisconsin DNR Division of Forestry for the formation of this partnership program between the two agencies. The Wisconsin Governors

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Council on Forestry supported the idea and legislation was drafted to create the program and partnership, and provide a stable source of funding.

The legislation created a fund for forestry education through the addition of a surcharge of one cent per tree seedling purchased from Wisconsin DNR Nurseries. The first years' surcharge generated approximately $500,000 from which the Division of Forestry also funded several other forestry education initiatives.

From this legislation was born a creative partnership program. The program is known as LEAF—Learning, Experiences, and Activities in Forestry. The mission of the program is to initiate and facilitate the development, dissemination, implementation, and evaluation of forestry education programs within Wisconsin's schools. The goals of the program are based around the advantages of such a program listed above.

The first step in the development of this program was to determine the important concepts that all Wisconsin students should know about Wisconsin's forests by the time they finish high school. To do this, input was solicited from an array of Wisconsin forest stakeholders ranging from environmental organizations to forest products industry representatives. Eighty-three individuals responded, submitting over 575 concept ideas. After combining like submissions and some revisions, 314 concept ideas were again refined with public input. Twenty-six people representing this wide base of stakeholders participated in a modified Delphi workshop to further narrow the submissions.

Final refinement led to 27 concepts further delineated into 60 subconcepts. The next step was to determine at what age these subconcepts were appropriate to be included in the K-12 curriculum. Twelve K-12 teachers representing each of the grade levels utilized the Wisconsin Model Academic Standards and their knowledge of the students' cognitive development to scope and sequence the subconcepts. Upon completion, the conceptual framework was published to:

- guide the development of the Wisconsin-based activity guides,
- serve as a framework for other K-12 forestry education efforts in Wisconsin,
- delineate the concepts teachers need to know to teach forestry topics, and
- promote forestry education in Wisconsin school districts.

Upon completion of the framework, research was conducted to determine the needs and interests of K-12 educators. Key information was collected that has further guided the development of the Wisconsin-based activity guides. Using the majority of responses as our reference, teachers told us that they:

- would be willing to infuse 5 to 7 lessons into their already busy curriculum,
- would prefer the lessons in age-specific units rather than as stand-alone activities,
- would prefer interdisciplinary units, and
- would prefer classroom-based activities with additional field-based enhancements.

During the summer of 2002, a group of teachers worked with LEAF staff to develop lessons based around the subconcepts identified in the above processes. Care was given to ensure that each of these subconcepts were indeed addressed in the objectives of the age-specific units where appropriate.

Professional development courses are currently being developed for educators. A face-to-face graduate-level course taught by adjunct faculty will be available statewide to disseminate the activity guides and provide training. Additionally, an on-line course is being developed to provide teachers with the necessary background information to feel comfortable teaching the lessons.

To further support education efforts at school districts, a school forest education specialist was added to the LEAF Program. About 40% or 193 school districts are part of the registered school forest program in Wisconsin. The program

allows schools to own forested land and reap the associated economic and educational benefits. Property use ranges from highly organized educational programs and management efforts to schools that don't realize they have a forest. The school forest education specialist will work to increase the use of these properties.

Results and Discussion

Through the formation of a partnership, the Wisconsin DNR Division of Forestry was able to capitalize on the expertise of the Wisconsin Center for Environmental Education and together create a multifaceted approach to K-12 forestry education. The program is modelled after a similar program started in 1996 at the WCEE on energy education (KEEP). To date, KEEP— the K-12 Energy Education Program has disseminated and trained 2000 teachers in the use of these materials. Several outside reviews have found this program to be highly successful in its usage by teachers and its overall contribution to energy literacy of Wisconsin citizens. The LEAF Program, although still under development, is working hard to repeat this success.

Conclusion

Educating the next generation about the forests in your State/Province is key to insuring the sustainability of these quality-of-life support systems. Thinking outside your "agency box" through creative partnerships and funding can help you to meet this need.

Notes

The Forest and Wetland Connection

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Introduction

Wetlands are essential life support systems to a tremendous array of wildlife species. In Ontario, 40 species of birds and 28 species of amphibians and reptiles depend on wetlands for one or more of their life requirements. A variety of studies have shown that movement between wetlands and adjacent uplands is important for salamanders (Semlitsch 1998), frogs (Berven and Grudzien 1990), turtles (Hall and Cuthbert 2000, Piepgras and Lang 2000), and snakes (Johnson and Leopold 1998). Forest managers already consider specific habitat needs of moose by prescribing no harvest buffers around wetlands to protect moose aquatic feeding areas. This practice will also benefit black bears that spend up to 60% of their lives in wetlands, red shouldered hawk that prefer beaver ponds for feeding areas, and wood ducks that nest in cavity trees within 300 m of productive wetlands.

Efforts to conserve wetland-breeding amphibians, cavity nesting waterfowl, and other wildlife species require a focus on conservation and management of both forest and wetland habitats. By providing municipal and forest management planners with better wetland mapping and evaluation information for input to planning, Ducks Unlimited Canada (DUC) hopes to influence the maintenance of the forest and wetland connection at the landscape scale. To address habitat connection at the level of the individual wetland we are providing landowners on private land and Sustainable Forest Licensees (SFLs) on Crown Land with management advice for the transition areas between upland forest and wetland.

Maintaining the Forest and Wetland Connection at the Landscape Scale

DUC, in partnership with the Ontario Ministry of Natural Resources (MNR) and others, has developed a technique that uses existing GIS and information derived from remote sensing imagery to improve the accuracy of currently available wetland mapping. The District Municipality of Muskoka (DMM) was chosen as a pilot area to develop this technique, and the new wetland coverage compiled identifies 59,949 ha of wetland in the DMM compared to the previous MNR wetland coverage of 25,245 ha—a 58% increase in wetland area.

In addition to producing enhanced wetland mapping, the project has automated the calculation of wetland evaluation scores in GIS using a regression equation previously developed by researchers at the University of Waterloo (Chisholm et al. *et al.* 1997). Since less than 1% of wetlands in this region have been evaluated for significance by the Northern Ontario Provincial Wetland Evaluation System (OWES), this new tool will provide an indication of the potential significance of any wetland complex if it were to be evaluated by the field-based OWES.

Approximately 50% of the land in central Ontario is privately owned. Between 1981-1996, in some parts of this area, population growth was 35 - 400% greater than the provincial average, and is putting pressure on natural heritage features in the region, including wetlands. DUC is working with several municipalities, including Muskoka, Haliburton and several townships in Algoma, to provide enhanced wetland mapping and evaluation products. This information will permit municipalities to designate potentially significant wetlands in their Official Plan schedules and, together with complementary wetland policies, set out expectations for the potential uses of wetlands and their adjacent areas.

On Crown land, the enhanced wetland mapping and evaluation product will enable

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forest management planning teams to identify wetlands as a value within the forest management planning process and to plan operations in accordance with Area of Concern (AOC) planning requirements, such as beaver habitat, moose aquatic feeding areas, and other wetland values.

Maintaining the Forest and Wetland Connection at the Site-specific Scale

Wetlands created or influenced by beavers are attractive to a variety of wildlife (Grover and Baldassare 1995), including waterfowl. During 1989 to 2000, DUC implemented a Beaver Pond Management (BPM) program that focused on (1) regenerating aspen in the vicinity of abandoned beaver ponds to provide future beaver food and stimulate reflooding, and (2) establishing nest boxes for cavity nesting waterfowl on productive ponds where natural cavities were limited. Based on our experience (Gabor et al. 1999), the following guidelines for a Beaver Habitat AOC were developed together with Ottawa Valley SFL managers.

1. Selecting candidate areas for regenerating aspen

- The beaver pond or wetland is identified as a warm water fishery or intermittent stream.
- The slope of land adjacent to the pond is less than 30% or 17 degrees.
- The upland forest stand has trembling aspen, big-tooth aspen, or balsam poplar in the canopy.
- An associated lake is less than 10 ha in area.

2. Size, shape and location of patch cuts

- A patch cut adjacent to a beaver pond will be a maximum of 200 m long and 50 m wide (depth) up to a maximum of 50% of the available shoreline for any given wetland.
- The remaining forested area adjacent to the beaver pond or wetland that has not been cut will become available for patch cutting after 20 years.

3. Type and timing of harvest

- The patch cut will consist of clearcutting to the treed edge of the pond, as measured from the high water mark.
- Patch cutting is not to occur during April 1 - June 30 of any given year, to avoid disturbing nesting waterfowl. Winter harvest is preferred to optimize poplar suckering in patch cut areas.

4. Location of landings and roads

- No landings or tertiary roads are allowed within the AOC, unless no other alternatives exist and approval is obtained by OMNR.

5. Regeneration of patch cut

- Patch cuts will be permitted to regenerate naturally to encourage the suckering of aspen and poplar.

6. Ensure availability of cavity nesting sites

- Six live cavity trees per hectare are to be maintained and preferably will be trees with a diameter at breast height (DBH) greater than 38 cm.

Hooded Mergansers, Common Goldeneyes and Wood Ducks all require natural cavities that are commonly found in maple, beech, elm, or oak trees in central Ontario's mixed forest, and in aspen in northern Ontario's boreal forest (Lumsden et al. 1980). Living trees accounted for over 90% of natural cavities used by Wood Ducks in Wisconsin, and more than 75% of suitable cavities were created from broken branch-heart rot rather than holes created by woodpeckers. Trees greater than 30 cm DBH produced suitable nesting cavities for ducks because they persist longer and provide more thermal insulation, protection from predators, perches, and room to house large clutches (Soulliere 1990). Several factors have diminished the availability of large diameter aspen and other hardwoods in wetland and forest transition zones in Ontario's forests, and the judicious application of the DUC beaver habitat AOC may contribute to future supplies of cavity nesting habitat.

Conclusion

Adoption of enhanced wetland mapping and evaluation tools will help forest managers to set out appropriate AOCs to conserve wetlands. For beaver pond wetlands, this may include prescriptions to regenerate aspen to provide adequate food resources for this keystone species. For other wetlands, non-harvested buffers will continue to permit many wildlife species to move between upland forests and wetlands. Concentrating on the maintenance of large-diameter cavity trees in transition zones between wetland/water and forest will yield more benefit to many wildlife species than practices that leave cavity trees equally distributed across the terrestrial landscape.

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Notes

Beyond Ownership Boundaries in the Upper Peninsula: The Nature Conservancy-Corporate Consortium Approach to Landscape-level Planning

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Introduction/Objectives

The reasons for the conservation of biological diversity in forests are many, and powerful, both for philosophical and economic reasons. Economically, diverse ecological systems provide greater and more sustainable opportunities for raw materials for industry. Diverse systems provide fundamental environmental services (Edwards and Abivardi 1998). For example, it has been reported that diverse systems have greater CO_2 storage capacity than non-diverse systems (Myers 1996). Possibly, and most importantly for timber extraction industries is the phenomenon of ecosystem resilience, or the ability of an ecosystem to recover from a disturbance (Perry 1988, Tilman and Downing 1994). Furthermore, diverse systems recover faster from disturbance than non-diverse systems, with higher productivity and reduced environmental problems such as erosion (Myers 1996).

Conservation of biodiversity requires both preservation, where areas of special concern are set aside (e.g., National Parks, preserves owned by non-profit organizations, wilderness areas within national forests), and careful management of the matrix, or remaining forest. The preserve strategy of conservation achieves potential protection of threatened and endangered species, rare communities, reference areas (or control sites to which managed areas can be compared), and species that are sensitive to human disturbance. However, there are limitations to this strategy. First, there are implementation challenges such as the amount of area available for preserves, and social and economical impediments that can make preserves inadequate to meet biodiversity goals. Second, it is ecologically challenging to determine the size, shape, and number of preserves, especially when trying to protect highly mobile organisms, and communities with patchy distributions. Third, demand for resources requires that the amount of land set aside for preserves is balanced with the amount of land that is available for extraction of resources. If a forest is largely set aside for preserves, then the extraction pressures may be intense on the remaining areas. Therefore, in addition to protected areas, we must develop management methods for the matrix forest that support preserves, and help to protect taxa and ecological communities that cannot be protected by preserves alone (many of the ideas presented here can be found in Lindenmayer and Franklin (2002)).

Responsible management within the matrix requires multi-scaled management that goes beyond the traditional stand-level management. This paper documents an approach to landscape-level management developed by The Nature Conservancy and the large industrial landowners of the Upper Peninsula of Michigan. The approach is designed to take forest management beyond the traditional stand-level planning approach by incorporating the activities and trends of adjacent landowners into the planning process with the goal of protecting biological diversity at a landscape scale. Planning at a landscape level is imperative to the conservation of biological diversity as "no forest is an island" (Kohm and Franklin 1997).

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Approach

Consortium participants included all of the large forest products producers of the Upper Peninsula of Michigan (representing roughly 2 million acres) and The Nature Conservancy. Development ***of the approach to landscape-level planning was achieved by:***

1. Creating guidelines for consortium participants emphasizing the need to move past previous barriers to success (i.e. the need for complete knowledge and agreement), cooperation and open communication, timely action and potential for the future
2. Exploring common goals and issues, such as certification needs and GIS capacity
3. Developing an action timetable
4. Drafting of the approach by a sub-committee that was elected by the group
5. Reviewing of draft approach by regional scientists
6. Reviewing of comments by the consortium, followed by rewriting based on comments
7. Finalizing the approach by participants
8. Testing of the approach in 2 pilot areas

The approach is structured enough to provide guidance, and improvement of forests, but is flexible enough to allow varied levels of implementation. This flexibility will increase potential for success as different members have varied levels of scientific capacity and certification needs.

Results and Discussion

The landscape planning approach we developed includes the following broad steps: (1) partitioning the landscape into functional units, (2) describing the landscape, (3) strategizing to accomplish goals, and (4) monitoring progress towards achieving goals.

Based on the utility of the National Hierarchical Framework of Ecological Units, we chose to use a level within the Hierarchy, the Land Type Association (LTA) for most planning purposes. Within the LTA we will collect the following where applicable/possible to develop the landscape description:

Biotic information:

- Vegetative communities (habitat type), such as forests of exceptional conservation value, threatened and endangered plant communities, forest cover types, pre-settlement vegetation amount of forested area and areas impacted by deer browse
- Historic disturbance patterns
- Wildlife and wildlife communities, specifically threatened and endangered species and associated habitats, migratory routes, critical habitats (both seasonal and year-round habitats), declining and vulnerable species
- Aquatic communities including the location of riparian areas, critical wetlands, vernal pools, and the identification of river, stream and lake networks
- Disjunct and edge-of-range populations
- Breeding bird, game bird, migratory waterfowl, amphibian and aquatic surveys
- Species and community locations not included in State Heritage Program databases

Abiotic information:

- Climate: average growing season length, snow depth, seasons of operability/duration of snow cover
- Landforms and soils: elevation, topography, erosion potential, and equipment operability
- Development plans ,such as recreation areas, trails, and boat access
- Special sites; e.g., historical, geological and research
- Road networks, current and planned
- Locations of utility lines
- Other uses, such as agricultural or residential
- Conservation areas and reference site locations (such as federal Research Natural Areas)

The Consortium agrees that its overarching goal is the conservation of biological diversity and that this is most effectively achieved through cooperative landscape-level planning. While individual landowner initiatives should be undertaken with this broad goal in mind, the Consortium recognizes that it is the cumulative effect of all activity among all landowners in the LTA that is most important. Through

cooperation and collaboration, a balance of representative habitats and management activities can be achieved in the planning unit. The Consortium recognizes the importance of developing additional, more specific goals as promptly as possible and that participants are committed to doing so as planning proceeds.

A monitoring effort that quantifies progress towards the desired goal is necessary. In general, monitoring should address progress towards the conditions outlined in the goal-setting step. For example:

- Are total area objectives for forest types and successional stages moving towards the stated goal?
- Are total length and location of roads in line with stated goals?
- Is the spatial distribution of forest types and individual stands in line with stated goals?
- Are operations complying with best management practices?

In addition to the monitoring information generated by individual participants from their GIS systems and operations inventory, various sources of public data can be used as additional monitoring tools. Examples include:

- Departmental of Environmental Quality stream surveys
- Department of Natural Resources (DNR) bag and creel surveys
- Breeding bird surveys (various agencies)
- US Fish and Wildlife Service drumming and parenting surveys
- DNR collar monitoring (wolf, bear, moose)
- DNR herptofaunal surveys

Monitoring efforts will also attempt to quantify the effectiveness of management implemented to protect rare components identified as part of goal setting. The information derived from monitoring may require changes in management and plan design. Conflicting and often inexact information about management effects on biodiversity complicates the monitoring process. The Consortium will review applicable literature and seek reviews from scientists working in fields directly related to specific monitoring needs.

Conclusion

To conserve biodiversity it is necessary to work at multiple scales using multiple strategies. In pursuit of protection of biodiversity, we developed an approach to landscape-level planning that will guide the timing, shape, and size of timber harvests in the Upper Peninsula of Michigan. We are currently testing the approach in 2 pilot areas and will be assessing the approach in terms of conservation value and ease of implementation.

Notes

Sustaining Ontario's Forests Through Strong Information Management

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Background

The Province of Ontario has a stated commitment to sustainable forest management, expressed in its Policy Framework for Sustainable Forests. Sustainable forest management is a shared responsibility of government, forest industry, and the public. Ontario's Living Legacy land-use strategy and the Ontario Forest Accord provide a framework for the forest industry, the public, and the Ontario Ministry of Natural Resources (MNR) to share responsibilities for managing and sustaining Ontario's forests.

This shared responsibility extends to all phases of forest management: planning, operations, monitoring, and reporting. The availability and accessibility of forest data and information are cornerstones to meeting our commitment to sustainability. Ontario has developed an information policy framework that lays out government and industry responsibilities for information sharing, and has developed information infrastructure, tools and standards to support planning, monitoring and reporting from local to provincial scales and to support public access to forest information. These approaches may interest other jurisdictions wishing to improve stakeholder access to information and understanding of forest management issues.

Changing Roles in Managing Ontario's Forests and Forest Information

The MNR maintains a stewardship role for regulating and overseeing the management of Ontario's Crown (public) forests. Many of the responsibilities for forest management planning and conducting forest operations have been transferred to the forest industry under a new business relationship that began in 1994.

As part of these changing roles and responsibilities, government has re-focused its role in regulating requirements and standards for information products and information exchange. As steward of the resource, the provincial government has become the regulator and manager of natural resource data to monitor, and to ensure the health and sustainability of Ontario's Crown forests and to maintain public access to information about the management of these forests.

Ontario has developed much of the policy direction to address these needs and concerns. However, this represents a delicate balancing act for government (acting as the data regulator and the stewardship agency), forest industry (the forest users and data providers), and the public (the forest owners and data users).

Forest Information Manual - Information Policy Framework

The Forest Information Manual prescribes the requirements for the exchange between the MNR and the forest industry of information needed for forest management planning. The manual describes the detailed requirements and standards for various types of information, such as: forest resources inventory, values, annual reporting, maps, forest operations prescriptions, forest operations compliance, and information systems used in forest management planning.

MNR and the forest industry have established various committees to support implementation of the Forest Information Manual and to jointly address and resolve issues related to information management, information access, and data exchange. Much of Ontario's success in advancing forest-based information management is due to

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the strong working relationship and commitment between MNR and the forest industry to exchange the most accurate and up to date data. This relationship involves over 30 companies licensed to conduct operations on Crown forests.

Using Information for Planning

Much of Ontario's efforts in strengthening forest information management have been focused on improving the data and tools available for forest management planning. Forest management planning deals with more than just harvest and regeneration scheduling. The planning process in Ontario is an integrated resource management process that considers such issues as forest fire protection, fisheries and wildlife habitat management, and remote tourism. Data and information management for this planning effort are predicated on giving local forest managers access to the necessary data and the common tools and infrastructure necessary to carry out local planning, while maintaining the capability to roll-up results and impacts – such as long-term wood and habitat supply – to regional and provincial scales.

Managing the large volumes of data mandated by the Forest Information Manual, and providing data and information to various users has required the development of a variety of data standards, data management infrastructure, and decision-support tools.

Forest Inventory and Forest Cover

Forest companies are now responsible for providing and maintaining the forest inventory on their licensed areas. MNR maintains responsibility for inventorying provincial parks, non-licensed areas, and private lands. These inventories are then meshed to provide a seamless coverage to support all aspects of forest management planning, since these plans must consider the impact of forestry operations on both the licensed area and the surrounding forests. A new standard for the forest inventory, called "Forest Cover", has been developed and provides a generic template for describing forested areas located anywhere in the province.

Other Forest Values

Ontario also records and manages information about non-timber values, such wildlife habitat. The public, forest industry, MNR, and other forest stakeholders help to identify these values and collect attribute information. The Natural Resources and Values Information System (NRVIS), created by MNR, provides the ability to use geographic data along with the corresponding attribute information. MNR has the mandate to manage and maintain the database, containing about 150 data classes and 690 geographic feature types.

Land Information Ontario

While NRVIS was designed primarily to support spatial data management for forest planning, there is a broader need to manage land-related information for a variety of purposes. MNR also leads the Land Information Ontario project (LIO), an on-going initiative to restructure the management and use of Ontario's land information infrastructure. The Ontario Land Information Warehouse component of the infrastructure maintains land-related information provided by Ontario government ministries (including OMNR's NRVIS data), data from the broader public sector (such as municipalities) and other stakeholders. The warehouse is online (www.lio.gov.on.ca), and allows the public to view and obtain information about Ontario's land information resources.

Forest Information Portal

The Forest Information Portal is a single-window, web-based interface for data exchange between the MNR and Ontario's forest industry, including, but not limited to, the data and information products prescribed in the Forest Information Manual. The Portal provides forest industry partners with access to land-related geospatial data; timber volume and revenue data; compliance monitoring information and other data and information related to managing forests. It allows the MNR to efficiently receive, verify and process data related to Crown forests at the local, regional and provincial scales. It will

also serve to meet additional requirements associated with data archiving and knowledge management. Some of the data exchanged by the Portal will be automatically written to or drawn from the Ontario Land Information Warehouse.

Accomplishments

The government-industry-public collaboration developed in Ontario has greatly improved the information required to plan, monitor, and report on the sustainability of Ontario's forests, and making that information more accessible has helped to reduce the conflict previously experienced in managing these forests for multiple and competing uses. Achieving this has required a significant on-going investment in the multi-party data collection, data management, and the technology infrastructure necessary to maintain and provide public access to the data and information.

The Future

Efforts continue to improve the quality and availability of information, and to improve its use in planning for and monitoring Ontario's forest resources. These initiatives include:

- Providing one-window access to forest information – for the forest industry and the public
- Building common spatial decision-support tools – working on a continuum of scales from local to provincial
- Strengthening the science behind the inventory, monitoring, assessment, and reporting of the state of our forest resources
- Using new information technologies to increase the timeliness and availability of forest information
- Improving data quality and reliability by identifying custodians and setting data standards

Ontario remains committed to using innovative information management policy, systems, tools, and infrastructure to sustain its forests. We expect that our approach to using modern information technology and strong information management principles to help meet our commitment to open and accessible forest-related information could be applicable to many other agencies responsible for managing public resources.

Notes

Forest Management from 30,000 Feet

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The Food and Agriculture Organization (FAO) of the United Nations was founded in 1945 and is one of the largest specialized agencies in the United Nations system and the lead agency for agriculture, forestry, fisheries, and rural development. An intergovernmental organization, FAO has 183 member countries plus a member organization, the European Community. With its global mandate, the FAO has a unique perspective on issues and challenges in sustainable forest management.

The FAO Forestry Program has developed its Strategic Plan to formally link it to the mandate, corporate strategies, and objectives of the overall Strategic Framework for FAO: 2000-2015, which was approved by the thirtieth session of the Conference of FAO in November 1999. This provides overall direction upon which the more detailed departmental implementation plans – the biennial Programs of Work and Budget – will be based. It is not a static document but will continually be developed and adapted to meet changing circumstances. Central characteristics of the Strategic Plan are discussed below.

The Forestry Program's Mission is "to enhance human well-being through support to member countries in the sustainable management of the world's trees and forests." It has the following goal statements:

- The contribution of trees and forests to sustainable land use, food security and to economic and social development and cultural values at national, regional, and global levels will be maximized
- The conservation, sustainable management, and improved utilization of trees and forest systems and their genetic resources
- An increase in worldwide access to reliable and timely forestry information

Focusing on the Forestry Program's vision, the scenario to aim for is an increase in the area of sustainably managed forests, a slowing of the rate of deforestation in the tropics, a decrease in forest degradation worldwide and an increase in the global area of trees and forests through afforestation and reforestation, especially of degraded land. The location, extent, composition, health and value of many of the goods and services represented by forest ecosystems and trees in the landscape will be more accurately known. Informed and constructive debate among a wide range of interest groups will be increasingly used to develop consensus on forest management, particularly in defining sustainable forest management and in striking a balance between environmental and developmental objectives. Policy changes will help to remove restrictions on forestry development, will promote participatory approaches towards their management and will encourage the equitable distribution of benefits. The role of trees and forests in contributing to food security (including the wood energy required for cooking food) and environmental protection will be enhanced and better recognized. More forests will be under controlled management and periodic assessments of indicators will show a trend towards long-term sustainability. There will be a greatly increased flow of investment into the sector, particularly in developing countries and countries with economies in transition.

Current priority activities include:

1. Global forestry statistics and information

- Develop a forestry information system
- Assess global forest resources
- Conduct forestry sector outlook studies

2. Technologies and methodologies for the conservation and sustainable use of trees, wooded lands, and forests

- Technical support to sustainable forest and wildlife management, including development

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and harmonization of criteria and indicators of sustainable forest management
- Support to activities in afforestation and reforestation, especially in countries with low forest cover
- Encourage the adoption of codes of environmentally sound harvesting and utilization practices and increase conversion efficiency
- Promote non-wood forest products, including their management, utilization, and marketing

3. Policy and institutional strengthening

- Support to national forest programs, especially capacity building
- Community Forestry Program

4. Support to international processes influencing forests

- Post-UNCED conventions
- New forest arrangements
- Ad hoc Inter-Agency Task Force on Forests (ITFF)
- International Year of Mountains, 2002

Of particular interest to this group, may be the Forestry Program's role in supporting the development of criteria and indicators for sustainable forest management. A key element of FAO's work in forestry is its support to countries in the development and implementation of criteria and indicators (related to environmental, productive, protective, social and economic functions of forests), which provide a framework for defining sustainable forest management and assessing progress towards that goal. While initial efforts have primarily been focused at the regional and national levels, criteria and indicators are now being adapted for application at the forest management unit level. If these forest management tools are to contribute to addressing issues of social injustice and ecological sustainability, there is a need for greater commitment to effective participation to capture the perceptions and impact on livelihoods of small producers, forest workers, forest dwellers, and adjacent populations.

A current focus of extension is thus to enhance the role of local populations in the development and application of criteria and indicators for sustainable forest management at the forest management unit level. The forest extension program undertakes to strengthen the capacity of extension services of private industry, government and non-governmental organizations (NGOs) in this regard.

Ontario Stewardship: "People and Forests in Harmony"

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Introduction

Ontario Stewardship is a program of the Ontario Ministry of Natural Resources (MNR) that was initiated in the summer of 1995. This innovative program is supported – not controlled by the OMNR. The success of the program is found in the foundations of volunteerism and community empowerment. The Ontario Stewardship network consists of 40 community-based "Stewardship Councils" located across Southern Ontario. MNR currently has Stewardship Coordinators committed to the support of these community-based Stewardship Councils. The landscapes in which these volunteer councils exist are a patchwork of both privately owned and Crown lands in Ontario. Councils are formed geographically by county and community.

Ontario Stewardship advocates that these lands be managed through a stewardship approach. The stewardship ethic is defined as:

An ethic in which humans care for the land as one part of the natural system.

To participate in environmental stewardship is to make a personal commitment to the land and to sustain and enhance it for generations to come.

Ontario Stewardship is in place to bring together people to advance resource stewardship. It brings together landowners, individuals, associations, and resource agencies with an interest in responsible land care, sustainable resource use, taking an ecological approach, and a healthy environment. The Ontario Stewardship council 'network' is involved in over 500 projects each year, ranging from natural resource education, living waters, wildlife and fish habitat, and population enhancement, and numerous forest-related community-generated projects. Many of these projects result in economic and community development, such as organizing or supporting events that draw people to the community, assisting new business initiatives, and enhancing landowners' ability to generate benefits from natural resources. These projects encourage local employment, enhance community capacity, and empower local leaders to act and direct local initiatives. This in turn encourages the volunteer commitment of time, expertise, and financial resources that have made Ontario Stewardship a unique, community led, government supported model.

The Model

Ontario Stewardship has 2 key components: the influential volunteer members of the Stewardship Councils and the MNR Stewardship Coordinator.

The Community Stewardship Councils are active groups that share a strong commitment to the program purpose and represent landowners, land interests, and resources in the area. They are respected people who provide a forum to recognize and influence community involvement and interest in stewardship. Representation is predominantly landowners, such as woodland owners, loggers, farmers, cottagers, naturalists, and recreationalists. Each Council has a chairperson and council members act much like a board of directors, in addition to getting directly involved in many projects. Councilors are apolitical and non-partisan.

Stewardship Coordinators are paid by MNR with the understanding that they work for the

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community through the Stewardship Council. Their task involves building the necessary relationships and partnerships, working collaboratively with agencies and associations, providing a window to the science and information within MNR and the extensive network that they are a part of. They may also take on an active role as the spokesperson for the Council. They will have a local network of personal contacts in the community. They also have a responsibility to actively participate in the greater network of 40 Councils, which is the Ontario Stewardship 'network'.

Accomplishments

The accomplishments of the Ontario Stewardship program for the 2001-02 are:

- 11,000 volunteers
- 170,000 volunteer hours
- 1,900 partners
- $21 million total contribution and effort for natural resources

What these figures do not reflect is the networking efforts and unique partnerships that have been created through this influence model. The emphasis on the importance of relationships has proven to be important. The people involved are doing an excellent job of building strong relationship at the community level – among landowners, with associations, agencies, and corporate and industrial sectors.

Ontario Stewardship is empowering, efficient, and accountable. Many important features of the program are contributing to our success...

- synergy among a diversity of groups – represented on the Councils and drawn together for projects
- diversity of interests, skills, and resources
- the time spent bringing in the mix of people and organizations makes scarce resources go farther
- building the right team of collaborators frequently means that each partner primarily provides what they do best – resulting in a high quality project that is efficiently delivered
- projects address resource management problems as they are recognized and defined locally – because the needs are identified locally and the projects are designed locally
- an ecosystem approach is built in by the involvement of a diversity of local interests and the participation of people with interests beyond the local community. This diversity of interests and abundance of people taking action under the umbrella of a common stewardship goal, is an excellent example of "thinking globally, acting locally"
- while there is a diversity of interests involved, the one characteristic that has been "managed" is the strength of representation by the landowners.

Conclusion

Ontario Stewardship is a model developed by the MNR to empower people to take part, in a real sense, in their own communities. The Ontario Stewardship network establishes connectivity and encourages the ecosystem approach. The program set out to improve stewardship of our natural resources, to create a collaborative resource management model, and to implement a model of influence. Much more than that has happened. The program has created a new relationship with communities, found better efficiencies, and unexpected alliances, and most importantly illustrated the unbelievable measure and results of true partnerships.

To learn more about *Ontario Stewardship*, visit http://www.ontariostewardship.org

Simulating Carbon Dynamics of Forest Ecosystems in the Lake Abitibi Model Forest in Ontario

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Introduction

Boreal forest ecosystems are expected to be sensitive to global climate change, with most concern focussed primarily on the changes in temperature and precipitation predicted over next century. In Ontario, temperature and precipitation during the growing season are projected to increase in the northeast and decrease elsewhere (Colombo et al. 1998). Forest structure, i.e., forest regeneration, growth, and mortality will be affected by climate change, and associated changes in forest ecosystem dynamics will in turn affect the climate. To investigate the potential effects of future climate change on forest ecosystems in Ontario, we used the Lake Abitibi Model Forest (LAMF) as a case study area. Here we report on the use of a new process-based forest growth and carbon dynamic model, TRIPLEX -(Peng et al. 2002), to simulate forest growth and carbon dynamics at forest stand level in the LAMF. This study also considered the development of carbon-based indicators for sustainable forest management at local, operational levels.

Materials and Methods

The LAMF is one of 11 model forests that have been supported by Canadian Model Forest Program. It consists of 1.2 M ha, of which approximately 0.9 M ha is forested, in the boreal forest of northeastern Ontario. We used data from 3 different research themes to simulate carbon dynamics for the LAMF ecosystem: (1) forest stand, including species, tree age, stocking, site class; (2) climate dynamics and distribution, including temperature and precipitation; and (3) soil texture, including soil type, and moisture.To prepare the data for the simulation model, we: (1) performed spatial calculations for the LAMF (more than 40,000 stands) using GIS technology; (2) interpolated climate data for each stand using a downscale algorithm. The modelling procedure consisted of (1) simulating carbon dynamics for the 1990s using TRIPLEX; (2) analyzing the carbon dynamics, distributions, and net carbon balance for the entire LAMF; (3) mapping 49 output variables for describing spatial distributions of LAMF ecosystems. The TRIPLEX model allowed us to partition and simulate carbon distribution among forest age classes, above- and belowground biomass and soil carbon, and quantify carbon-based indicators such as NPP (net primary productivity) and net carbon balance.

Results and Discussion

(1) *Biomass, carbon density, and tree growth:* Table 1 summarizes carbon levels of biomass and soil. Figures 1a and 1b show the distribution of biomass density (above- and belowground) and soil carbon density in the LAMF for 2000. Both biomass and soil carbon density are higher in the northern part of the LAMF than the south, likely because of better soil conditions and the predominance of older stands in the north. We compared simulated tree height with observed tree height to test the validity of the model predictions. The simulation results are in line with the field measurements, with coefficients of determination (R^2) of 0.93, 0.83, and 0.88 for

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Table 1. *Summary of general properties and carbon dynamics of areas of the LAMF forest ecosystem in 2000; carbon density is calculated only for forested land.*

	Iroquois Falls North	Iroquois Falls South	LAMF
Ecoregion	3E3	3E6	-
Average forest age (years)	76	55	72
Forest land area (ha)	739,922	159,590	899,512
Biomass carbon (Mt C)	49.2	6.3	55.5
Litter and soil carbon (Mt C)	75.8	7.9	83.7
Biomass carbon density (t C ha^{-1})	61.9	51.8	60.5
Litter and soil carbon density (t C ha^{-1})	98.4	66.3	93.9

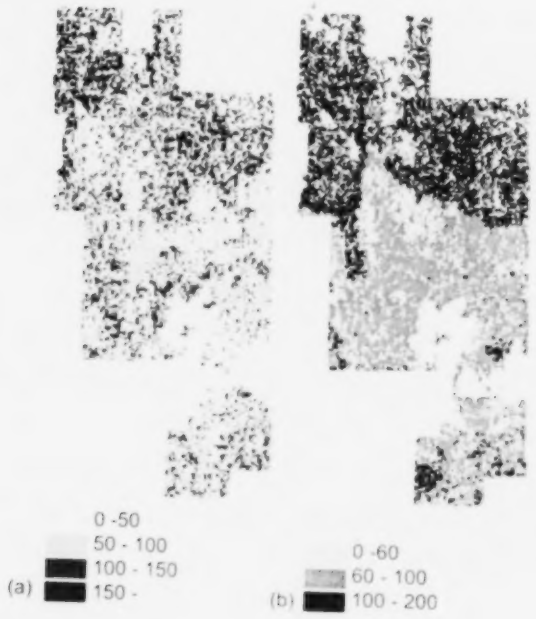

Figure 1. *Distribution of (a) biomass density (t C ha^{-1}) and (b) soil carbon density (t C ha^{-1}) in LAMF for 2000. Biomass density includes above- and belowground biomass; soil carbon density includes litter carbon.*

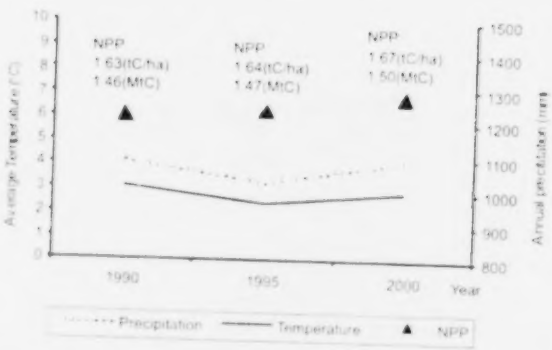

Figure 2. *Annual NPP dynamics in the LAMF relative to temperature and precipitation.*

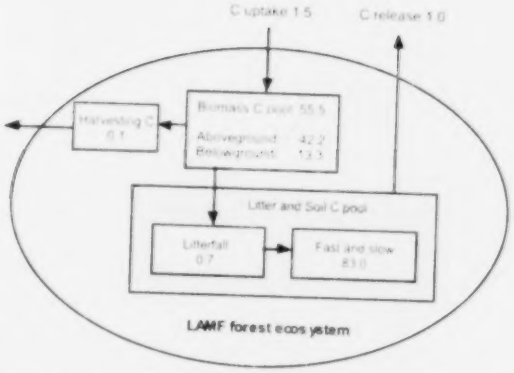

Figure 3. *Net carbon balance (Mt C) of the LAMF forest ecosystem in 2000; biomass and soil carbon stocks were estimated before harvesting. Wild fire was not considered.*

black spruce, jack pine, and trembling aspen, respectively.

(2) *The effects of climate conditions on annual NPP.* Figure 2 shows that mean annual precipitation and temperature varied somewhat between 1990 and 2000. Annual NPP also varied to some extent with the changing climate (based on mean annual precipitation and temperature) but seemed to gradually increase over the period.

(3) *Net carbon balance.* Figure 3 illustrates that the net carbon balance was estimated around 0.5 Mt C yr^{-1}, and net biome production (NBP = carbon balance after harvesting) was approximately 0.4 Mt C yr^{-1} between 1990 and 2000. Thus, the LAMF ecosystem was a carbon sink during the 1990s, although, on the whole, Ontario's forest ecosystems were thought to be a carbon source (-31 Mt C estimated in 1990) (Peng et al. 2000). This may be because the younger stands (average stand age is 72 years) in the LAMF were very productive and very few disturbances (e.g., harvesting, fire) occurred during this period. Allowable harvest in the LAMF is limited between 1990 and 2015. Actual harvested volume (549,000 m^3 yr^{-1}, 0.12 Mt C yr^{-1}) in the LAMF was lower than the allowable harvest, which is approximately 750,000 m^3 annually (e.g., 0.16 Mt C yr^{-1}). As well, the effects of forest fire dynamics were not included in our analysis because the forest fire simulation module has not been incorporated into the current formulation of the TRIPLEX model. However, fire did not occur to any great extent during the time of this study, with total burned area comprising only 0.38% of the LAMF in the 1990s (OMNR, 2000). Thus, carbon released by forest fire would have a relatively small impact on the total carbon balance of LAMF ecosystem.

Notes

POSTERS

Intensive Forest Management Science Partnership: NEBIE Plot Network

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Background

Through Living Legacy Trust funding, ULERN and partners are comparing the effects of natural forest disturbance with those of a range of intensities of silvicultural practices throughout the boreal and Great Lakes St. Lawrence forests of Ontario. The objectives of this project are to:

- Determine the effects of natural disturbance and silvicultural practices on tree survival, growth, wood quality, and species and genetic diversity
- Monitor the effects of silvicultural practices on microclimate, soil moisture and nutrient cycling, vegetation diversity, and wildlife habitat
- Develop a defensible database to accurately forecast allowable cut while maintaining ecological and economic viability

Living Legacy Trust[1] awarded the Upper Lakes Environmental Research Network (ULERN) and its project partners $903,000 over 2.5 years to initiate the research program dubbed NEBIE (**N**atural disturbance, **E**xtensive, **B**asic, **I**ntensive, and **E**lite). For the purposes of this project, the silvicultural intensities under study have been put into a standard framework adapted from Dunster and Dunster (1995) and Bell *et al.* (2000):

- **Natural disturbance**: Forest ecosystem responds (e.g., to fire, insects, and/or disease) without human inputs
- **Extensive**: Minimum stocking is achieved and desired tree species are free of major insect pests
- **Basic**: Minimum stocking is achieved and desired tree species are free of interspecific competition and major insect pests
- **Intensive**: Near full stocking is achieved and desired tree species are free from inter- and intraspecific competition and major insect pests
- **Elite**: Full stocking is achieved and desired tree species are free from inter- and intraspecific competition, nutrient deficiencies, and major insect pests

NEBIE research will be conducted on 10 study sites, selected to cover the major commercial forest types, within northern and central Ontario (Figure 1).

The project will use a Randomized Complete Block (RCB) design with 2 factors: (1) tree species referred to as "installation sets" and (2) management intensity (NEBIE). Installation sets will include: jack pine, black spruce (upland and lowland), trembling aspen, white birch, white spruce mixedwoods, white pine mixedwoods, and tolerant hardwoods/yellow birch. Each treatment will be replicated 4 times. Installation sets will be established near Sioux Lookout, Dryden, Thunder Bay, Wawa, Kapuskasing, Timmins, North Bay, and Petawawa. Plots will be 100 x 200 m (2 ha).

Integrated silvicultural treatments will be selected based on pre-harvest surveys.

Data Collection and Analysis Methodology

The following data will be collected at each of the study sites:

- Crop tree measurements, including height, diameter, stocking, will follow the minimum standards for permanent sample plots and stocking surveys (Hayden *et al.* 1995, OMNR 1997).

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Figure 1

Expected Outcomes

References

- Enhanced sampling for species diversity will occur on a minimum of 6 installation sites. Species abundance for all non-tree species will be assessed within each sub-plots by individual species and layer codes (Sims *et al.* 1989). Microhabitat cover (e.g., rock, exposed mineral soil, and wood) will also be assessed.
- Genetic diversity research will be conducted following stand establishment in year 10.
- Enhanced soil sampling will be conducted within 6 installation sets. This will include data on aboveground nutrient pools, fine litterfall, soil chemistry, nutrient turnover and leaching, aboveground and belowground carbon pools and coarse and fine woody debris. Base line soil elemental and nutrient pool inventories will be conducted for the other treatments (uncut forest and extensive and basic silviculture) and other species in the remaining installation sets. Base-line sampling will also include soil total elemental composition and physical parameters. The data collected from the baseline sampling will be coupled to data collected from the enhanced sampling to develop conceptual models and apply mathematical models to silviculture and soil dynamics. Conceptual model formulation will involve identifying important soil processes from the enhanced study and using the baseline study to determine if soil processes respond similarly over multiple geographic ranges, forest types, and soil types. Mathematical models such as the Nutrient Cycling Model (NuCM; Lau *et al.* 1992) and CENTURY (Parton *et al.* 1987) will be used to develop scenarios of silvicultural impacts on soil nutrient cycling and carbon pools in Ontario.
- Soil temperature and moisture on each site will be measured throughout the assessment years using data loggers.
- Surveys for insects and diseases will be conducted as required.
- A *real options* economics model will be used to examine proposed investments in intensive forest management in Ontario.

Figure 1. *NEBIE locations: active sites (black text), proposed (white text).*

Expected Outcomes

This research will help resource managers to:

- Maintain or enhance fibre quantity and quality
- Maintain soil and water resources
- Conserve biological diversity
- Reduce risk of losses to fire, insect, or disease
- Maintain economic sustainability

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Active Research Partners as of August 2002

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Margo Shaw, Sharon Cuddy and Monique Wester

Ontario Ministry of Natural Resources
Lisa Buse, Bill Cole, Randy Ford, Sylvia Greifenhagen, Dennis Joyce, Jim McLaughlin, John McLaughlin, Pengxin Lu, Andree Morneault, Abby Obenchain, John Parton, Bill Towill, Sandra Wawryszyn, and Murray Woods

Forest Industries
Gord Cummings (AFA); David West (Bowater); Glen Niznowski (Buchanan); Dan Bowes (Clergue); Chad Anderson, Jeff Leach, Al Stinson (Tembec); and Janet Lane (Weyerhaeuser)

Natural Resources Canada
Steve D'Eon, Doug Pitt, and Suzanne Wetzel

Universities and Colleges
Jian Wang and Quing-Lai Dang (Lakehead); Peter Dillon (Trent); Glen Fox and Steve Newmaster (Guelph); Margaret Insley (Waterloo); Changhui Peng (South Dakota); and Bob Currell and Mark Harvey (Sault College)

Non Government Organizations
Mark Ryans (FERIC) and Margaret Penner (Forest Analysis Ltd.)

[1] *Living Legacy Trust is a $30 million fund established by the Province of Ontario to invest in natural resource management projects in northern Ontario. Projects receiving funding will bring economic, social, and recreational benefits to the people of Ontario and serve as models of excellence in forestry and fish and wildlife management practices. The trust addresses the province's commitment to provide improved opportunities for the forest industry and to enhance fish and wildlife access and management. Through Ontario's Living Legacy, protected areas were increased with the agreement that there would be no net loss of income for the forest industry. This requires increased reliance on intensive forest management on the remaining forested areas.*

Notes

Development of a Modern Site-Quality Evaluation Technique for Hardwood Forests of Central Ontario

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Introduction

Occupying some 5 million ha in central/southern Ontario (OMNR 1998), the importance of the mixed hardwood forests to Ontario cannot be understated. The Great Lakes-St.Lawrence forest region in Ontario provides a number of benefits to the public, including wildlife habitat, recreational opportunities, and jobs through the forest industry it supports. The high-value nature of many forest products in this region makes it even more important that foresters and land managers in the area manage the forests in an economically and ecologically sustainable manner.

An integral part of sustainable forest management is the identification of forest sites most suitable for the various forms of forest use and development. Additionally, foresters require methods of evaluating which of the forest lands available to them are most productive to determine which species to manage on different sites, as well the level of management intensity. Forest site-quality evaluation is therefore extremely important. Site-quality evaluation refers to the estimation of the capability of forest land for growing trees (Carmean 1996).

Many of the site-quality evaluation tools available to foresters in other areas have not been satisfactorily developed for the tolerant mixedwood forests in central Ontario. Foresters instead rely on techniques and information derived from other areas such as the mid-western United States. While many of these techniques are sound, the validity of their application to central Ontario forests needs to be tested. What is really needed is a set of original, locally derived site-quality estimation tools to provide foresters with a solid basis for management decisions, and to determine the applicability of site-quality evaluation techniques derived in other areas to central Ontario.

A study was initiated in 2001 with the following objectives:

- Develop valid, locally derived, modern polymorphic site-index curves for major tolerant hardwood species in central Ontario
- Test the validity of Carmean's (1978) site-index curves in application to central Ontario's tolerant hardwood forests
- Investigate and account for the effects of species composition and age on site index in mixed-species, uneven-aged tolerant hardwood forests in central Ontario, and explore methods of applying site index to this situation

Approach

The primary commercial hardwood species in central Ontario were the focus of this study: sugar maple (*Acer saccharum* Marsh.), red oak (*Quercus rubra* L.), American beech (*Fagus grandifolia* Ehrh.) and yellow birch (*Betula alleghaniensis* Britt.). The study area was the main region of central Ontario where these species occur together, including the North Bay region, Algonquin Park, and Haliburton Forest.

A stratified random sample was carried out, with strata based on convenience and land

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tenure. This resulted in 3 complete simple random samples, 1 in each subregion. In each region, at least 2 stands were randomly selected for each level of site quality (good, medium, poor) for each of the target species, resulting in at least 6 plots distributed across the entire range of site quality over which that species occurred. An effort was made to sample both pure even-aged and mixed uneven-aged stands.

In each sample stand, and 100 m^2 circular plot was established and the following descriptive information was recorded: ecological site description, site features, site tree description, soil description, understory vegetation, and heights and diameters of trees occurring in the plot. In each plot, 3 free-growing, well-formed, uninjured, dominant or codominant site trees were felled for stem analysis. These were AGS trees, as free and healthy as possible.

Discs collected in the field were then sanded, prepared, and scanned at high resolution for processing in WinDendro tree-ring increment measurement software. All data were managed with spreadsheet and database software.

Preliminary Results and Discussion (Analyses in Progress)

The data are currently being examined for errors and erratic measurements. Once this is complete, curvilinear regression methods will be used to generate a preliminary set of modern, polymorphic site-index curves based on plots located in pure, relatively even-aged stands. These preliminary curves will then be used to evaluate Carmean's (1978) site-index curves for tolerant hardwoods, and determine their applicability to central Ontario. It is suspected that these curves will prove to be significantly different from those developed in this study (they will likely overestimate height growth significantly for the same species in central Ontario). Finally, these preliminary "baseline" curves will be compared to the observed height-growth patterns for the same species in the mixed stands in the sample. An attempt will be made to account for and model species interactions and the effects of suppression on observed site indices, especially for sugar maple.

Conclusion

There are currently no locally derived site-index curves or reliable, sound, numerical methods of site-quality evaluation for the tolerant hardwood forests of central Ontario. Work is currently underway to address this problem by developing site-index curves based on stem analysis of sample plots located in central Ontario. These curves will then be used to verify/dispute the applicability of Carmean's (1978) site-index curves from the mid-western United States. Finally, the effects of species interactions and uneven-aged stand characteristics on site index will be investigated.

Acknowledgements

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Implementing Indicators of Sustainability across 20 States

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[3] USDA Forest Service, Northeastern Area, State and Private Forestry

Introduction

Across 20 states in the Northeast and Midwest (Figure 1), including Minnesota, Michigan, and Wisconsin, the state foresters and forest resource planners have been working collaboratively with the Northeastern Area, State and Private Forestry branch of the USDA Forest Service (NA) to develop sustainability indicators. The Northeastern Area Association of State Foresters (NAASF) and NA share a commitment to the sustainable management of forests and have endorsed the Montreal Process framework of criteria and indicators as the primary basis to guide forest sustainability assessment. The Montreal Process is an accord among 12 countries, including the United States and Canada, establishing a set of 7 criteria and 67 indicators to track the conservation and sustainable management of temperate and boreal forests (Montreal Process Working Group 2001).

Base Set of Indicators and Associated Metrics

Commissioned by NAASF, a base set of indicators were developed through an iterative process, by a work group of Northeastern Forest Resource Planners Association members and NA staff. These indicators are consistent with the Montreal Process framework, addressing ecological, economic, and social values (Box 1). The indicators were chosen to be a comprehensive set that addresses major aspects of each criterion and represent a balance between the need to be both concise and sufficient for our purpose. In this way, the suite of indicators complement work at the national level, are useful for regional level sustainability assessment, and may serve as a starting point for State level sustainability assessments.

Drawing primarily on existing data to minimize new data collection, a comprehensive assessment of data available to determine the most suitable metrics for each indicator is being completed. Metrics proposed for each indicator were selected to be meaningful at regional, State, and subregional scales and to allow tracking of trends over time. Through this process, we have identified data that are available from a variety of sources and have compiled detailed information about these data, including reliability, comparability across states, dates of reference data, reporting cycle, consistency over time, limitations, process for obtaining the data, source and contact information, and Web site addresses. As a part of this process, we are also identifying

Figure 1. *This effort involves 20 States in the Northeast and Midwest United States.*

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data gaps and inconsistencies that need to be addressed to adequately report the full suite of indicators.

In an effort to consider all possible data sources, individual state forestry agencies were surveyed for information about data available at the state level, and data used by a number of efforts was reviewed, including the U.S. Roundtable on Sustainable Forests, draft *National Report on Sustainable Forests—2003*, technical reports from the USDA Forest Service Forest Health Monitoring program, the *State of the Nations Ecosystems* work by the H. John Heinz III Center, and regional sustainability assessment work conducted by the Northeastern Area.

Long-term Commitment to Indicator Reporting by the Northeastern Area of the USDA Forest Service and the Northeastern Area Association of State Foresters

In 2001, NAASF adopted the base set of 18 indicators to assess the sustainability of forests across the 20 states. The base indicators are intended to be common measures that facilitate information sharing across administrative and jurisdictional boundaries, link to national-level work, and are a valuable means of tracking the effectiveness of agencies' programs and policies. NA and NAASF have made a commitment to develop comprehensive regional assessment reports using the suite of indicators at least every five years. In addition, information suitable for analyses at the State, subregional, multi-state and ecoregional scales will be made available on a Web site to allow States and other entities to conduct forest sustainability assessments. For this indicator reporting, we plan to develop a Web-based information system that will provide indicator data and metadata and the ability to query for summary information and trends, generating reports, graphs, tables, and maps, as well as links to related information. Benefits of online indicator reporting include the ability to post new data as soon as it becomes available and providing stakeholders with easy access to the data, electronically for their own use.

Sourcebook and Web Clearinghouse for More Information

As an earlier result of this effort, we have produced a sourcebook on criteria and indicators of forest sustainability (USDA Forest Service 2002). This publication summarizes information on the development and use of criteria and indicators by 60 sustainability/indicator efforts, documents the NA and NAASF initiative, and presents lessons learned on the implementation of criteria and indicators. As part of the overall initiative, NA serves as a clearinghouse to provide information about sustainability and related efforts. A key component of the clearinghouse is the NA's Sustainability Program Web site: **http://www.na.fs.fed.us/sustainability**. In addition to up-to-date information on the status of the NA/NAASF sustainability efforts, this site posts information on national, regional, and local sustainability assessments, State forest resource planning, ecological classification and mapping, and forest certification.

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Box 1 *Montreal Process Criteria and NA/NAASF Base Indicators of Forest Sustainability*

Criterion 1: Conservation of Biological Diversity

1. Area of forest land relative to nonforest land, area of timberland, and area of reserved land
2. Extent of area by forest type and by size class, age class, and successional stage
3. Degree of forest land conversion, fragmentation, and parcelization
4. Status of species and communities of concern with focus on forest associated species

Criterion 2: Maintenance of Productive Capacity of Forest Ecosystems

5. Area of timberland (note: this is also part of indicator #1 above)
6. Annual removal of wood products compared to net growth

Criterion 3: Maintenance of Forest Ecosystem Health and Vitality

7. Area and percent of forest affected by damaging agents such as insects, disease, exotic/native species, fire, storm, land clearance, and domestic animals

Criterion 4: Conservation and Maintenance of Soil and Water Resources

8. Area and percent of forest land with significantly diminished soil organic matter, erosion, compaction, and/or changes in other soil chemical or physical properties
9. Area and percent of forest land adjacent to surface water and area of forested land by watershed
10. The condition and vulnerability of aquatic systems by watershed

Criterion 5: Maintenance of Forest Contribution to Global Carbon Cycles

11. Total forest ecosystem biomass and carbon pool, and contribution of forest ecosystems to the total carbon budget

Criterion 6: Maintenance and Enhancement of Long-term Multiple Socio-economic Benefits to Meet the Needs of Societies

12. Value and volume of wood and wood products production, consumption, imports, and exports
13. Outdoor recreation activities and use, recreational facilities and use
14. Public and private investments in forest health, management, processing, manufacturing, and research
15. Public, private, and industrial ownership and land use (including acres of specially designated land)
16. Trends in forest-related sectors' (e.g., wood products, recreation, and forest management) earnings and employment

Criterion 7: Legal, Institutional and Economic Framework for Forest Conservation and Sustainable Management

17. Existence, type, and monitoring of voluntary or mandatory best management practices
18. Existence, type, and frequency of forest-related planning, assessment, and policy review, including cross-sectoral planning and coordination

Notes

Tree Instability in Jack Pine Plantations

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Introduction

Poor root form can lead to tree instability that results in stem form defects (e.g., sweep, crook), especially in jack pine (*Pinus banksiana* Lamb.) plantations. Stem form defects may significantly reduce usable wood volume, wood quality, and product yield and value. Poor root form may be traced back to reforestation practices, with stem deformations occurring more frequently in plantations than in naturally regenerated forests.

Our study of root form and instability in jack pine plantations of Ontario has 3 components. First we evaluate jack pine root forms grown in a variety of container types currently used in Ontario. We plan to follow the growth and development of these seedlings after planting in pot and field trials in summer 2003. Second is a survey of jack pine plantations varying in age and origin, through which we will assess the incidence of tree instability and stem form defects. Results from the survey will lead to the third component that includes an evaluation of wood supply and analysis of economic impacts due to stem deformations.

We present results from a survey of seedling root forms grown for 1 season in various containers: Jiffy pellet®, Multipot®, Starpot®, and 2 types of Styroblock® (Copperblock® and Ventblock®). Jiffy pellets® have soft mesh walls, the other container types have hard plastic (Multipot® and Starpot®) or styrofoam walls (Styroblock®). Starpot® cavities have side slits that promote air pruning and Copperblocks® are coated with paint that chemically prunes roots at the container wall.

Approach

Jack pine seeds were sown into cavities/pellets in June 2002, at the Ontario Forest Research Institute, Sault Ste. Marie, and grown in a greenhouse until September when they were moved outside. As container types vary in drying rate, seedlings were watered and fertilized on different schedules. Half the Jiffy pellet® trays were root pruned 'early' at the time of transfer outdoors. In late November, seedlings were moved indoors for bundling, boxing, and cold storage. The remaining half of the Jiffy pellet® trays were pruned just prior to bundling, making up the 'late' pruning treatment for this container type.

To evaluate root system form and root development after planting, 2 groups of 20 seedlings from each treatment were randomly selected. These seedlings were cold stored until January 2003. After removing soil from root plugs of the first group of seedlings, their root systems were categorized as follows:

(1) *Ladder*--root system with a central taproot from which first-order laterals radiate symmetrically at approximately equal distances along the taproot length (*considered the most favourable root form for producing a stable root system after planting*, Figure 1)

(2) *Asymmetric*--similar to *ladder* but the taproot is markedly off-centre so that first-order laterals are distributed on one side of the plug

(3) *Sinker*—similar to *ladder*, but first-order laterals have grown down the container wall to the bottom of the plug

(4) *Elevator*—a *sinker* root system in which first-order laterals have grown upwards after reaching the container bottom

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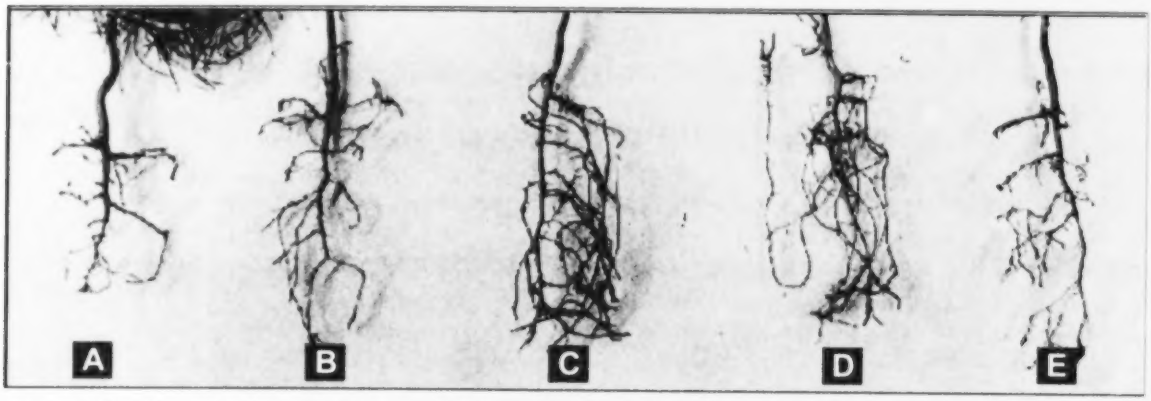

Figure 1. *Root forms of jack pine seedlings: (A) ladder (soft wall form), (B) ladder (hard wall form), (C) sinker, (D) elevator, and (E) asymmetric.*

(5) *Asymmetric elevator*—off-centre root system with first-order laterals growing around and then up and down the container wall

(6) *Truncated*—root system with a stunted taproot and first-order laterals descending to the bottom of the plug.

Since the mesh walls of Jiffy pellets® predispose them to inter-rooting, pruned unattached roots were collected from Jiffy pellets®. Intact root systems and detached roots were oven-dried to constant mass.

To evaluate root development, we transplanted the second group of seedlings into sand-filled 3-L pots. The seedlings are currently growing in a greenhouse. Once first-order lateral roots have developed sufficiently, we will evaluate seedling root structure.

Results and Discussion

Each container can produce a root system with a central taproot and first-order lateral roots symmetrically distributed throughout the plug, characteristics important for stability. Stability-related variations in this theme characterize different containers. Hard-walled containers that do not air or chemically prune lateral roots at the container wall produce root systems that are vertically distributed (i.e., *sinker*, *elevator*; Figure 1) and thus are less likely to provide good horizontal anchorage (Table 1) (Burdett 1979).

Container types that prune first-order lateral roots tend to produce the more ideal *ladder* root form. Jiffy pellets® produce this form, but through mechanical root pruning, lose 17-65% of their root mass (Figure 2). Some of the

Table 1. *Percentages of seedling root forms by container type.*

Container type	N	Ladder	Sinker	Elevator	Truncated	Asymmetric	Asymmetric-Elevator
Jiffy 28-140	40	82	0	0	8	10	0
Jiffy 28-165	40	87	0	0	5	8	0
Jiffy 30-140	40	90	0	0	8	2	0
Multipot	20	0	30	65	0	0	5
Starpot	20	95	0	0	0	5	0
Styro - Copperblock	15	67	0	0	13	20	0
Styro - Ventblock	20	0	40	45	5	5	5

consequences of pruning (i.e., ripped taproots and scars where lateral roots were torn from the taproot) could potentially impede water uptake or expose seedlings to increased risk of pathogen infection after planting. Early pruning limits the amount of inter-rooting and thus the loss of root mass.

Root systems with *truncated* taproots or *asymmetric* distributions of first-order lateral roots occur among most container types. Truncation may be due to a perched water table in the bottom half of the plug. Asymmetry likely results from off-centre sowing. Two individuals sowed seed thus differences in asymmetry among container types may reflect their care in sowing.

Root system form could be improved in a number of ways. Container designs have been modified over time and this trend is likely to continue. For Jiffy pellets®, lost root mass could be managed by pruning date. Seedlings with poor root form could be culled during the growing season or just prior to planting.

Conclusions

The characterization of differences in root system form is the first step in relating root form to tree growth, stability, and stem form. Clearly, we need to follow the fate of seedlings with varied root forms to elucidate the causes of stem form defects related to instability. Once we have a better understanding of links between container-grown root form and instability, we can study ways to reduce root characteristics that are demonstrably undesirable.

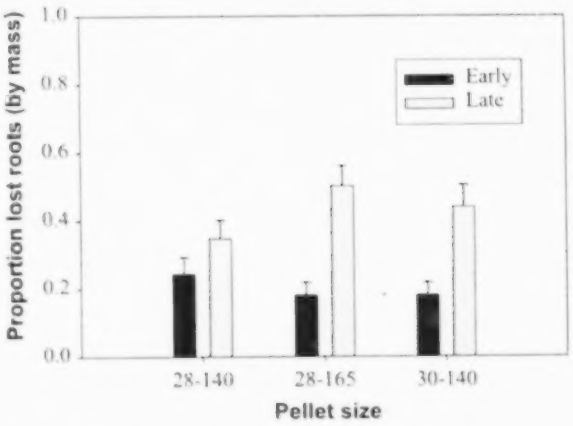

Figure 2. *Differences in percentage root mass lost when pruning is done early (September 16) rather than late (November 30) in Jiffy pellets of three sizes (means with 2SE).*

Containers shape early root system development, with some container types producing root systems that may be less stable after planting. If jack pine plantations in Ontario have economically significant levels of stem deformities due to poor stability, research aimed at improving container design and cultural practices could help alleviate the problem for future plantations. Innovative methods of processing logs with such deformities could enhance the economic value of afflicted plantations.

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Notes

Vertical Laser Pulse Return Frequency Distributions within Tree Canopies Using Airborne and Ground-based Lidar Systems

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Introduction

Airborne LiDAR (Light Detection And Ranging) instruments can be used experimentally to gather information on forest canopy structure. One limitation of using airborne LiDAR data for a quantitative description of vertical canopy structure is related to the high probability of laser returns from both the top of the canopy and the ground, with a lower probability of laser pulse returns from within the canopy. The shadowing of leafy biomass within the canopy by leaves and branches near the top of the canopy omits vegetation within the canopy when using spectral remote sensing instruments to examine forest biomass, leaf area index (LAI), and forest health. Radiation reflected from biomass within the canopy tends to intersect with the undersides of other leaves, and often does not reach the sensor, thus 'shadowing' leaves within the canopy. Such shadowing reduces surrogate approximations of LAI, a key parameter in many hydrological, process-based meteorological, and numerical weather forecasting models.

New active sensor technologies, especially those of laser altimetry (Light Detection And Ranging instruments) use pulses of energy that reflect back to the sensor discretely (for example, at two recorded intervals), or continuously (at more than two recorded intervals), at the top, within, and/or below the canopy. LiDAR, therefore, is able to record the height of the tree, structure of the canopy, and can be used to approximate measures of LAI, leafy biomass volume, and height of live crown (for example, Lefsky et al. 1999, Means et al. 2000, Friedlaender and Koch 2000). Unfortunately, airborne LiDAR also suffers from the effects of shadowing within the canopy, and this may cast uncertainty as to whether LiDAR should be used for examining forest leafy biomass and LAI without accounting for missing data within the canopy. Schematic diagrams of pulse returns within the canopy for airborne and ground-based LiDARs are illustrated in Figures 1 and 2.

This study attempts to quantify shadowing/laser pulse omission errors within the canopy by comparing both airborne and ground-based LiDAR datasets of the same red pine forest plot. Look angle will also influence shadowing within the canopy, both in the airborne and ground-based LiDAR systems, and these should be considered when examining areas within the canopy that are shadowed by surrounding biomass.

Study Area and Data Collection

This study examines vertical laser pulse frequency distributions within the canopy of a managed red pine forest stand in The Vivian Forest, also known as the York Regional Forest Tract, approximately 50 km north of Toronto, Ontario using coincident airborne scanning LiDAR data and a static ground-based scanning LiDAR. The Vivian Forest consists of managed red pine plantations, unmanaged red pine plantations, and natural sugar maple/mixed deciduous stands at various stages of re-growth. Managed red pine stands may have little understory, or alternatively, may be unmanaged and have an extensive understory of sugar maple and young red pine. The diversity of this forested area, both from topographic and plot-level perspectives, have made it an important study area for testing airborne and ground-based LiDAR systems by Optech Inc., a local LiDAR manufacturer. For this preliminary study, one representative 30 x 30-m red pine plantation has

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been chosen to exhibit the potential for shadowing within the canopy. To date, 6 airborne LiDAR surveys have been flown over the Vivian Forest and 1 ground-based LiDAR survey has been completed within the 30 x 30-m managed red pine plantation with little understory, and also, within a 30 x 30-m deciduous plot of mixed understory (from a larger several km study). This study will use 2 ALTM datasets, one flown in April 2002, for use in generating accurate ground topography beneath the forest canopy and the second, flown in July, 2002 for vegetation canopy analysis.

A ground-based LiDAR survey using Optech's ILRIS system was also initiated coincident with the July 5, 2002 ALTM survey of the Vivian Forest, and specifically, within a managed red pine conifer plot. The ILRIS system has a 40-degree field of view in both directions and a pulse rate of 2 kHz. Where the ALTM has a resolution of approximately 15 cm in the z, the ILRIS has been set to a resolution of 1 cm (for this study) and boasts spatial resolutions within 1 mm in all directions. The ILRIS LiDAR system was set up at 5 locations surrounding the 30 x 30-m homogeneous red pine plot and pointing towards a central point for co-registration between scans. Co-registration of the 5 scan lines with referenced (using Applanix POS backpack) control point 'target' markers was performed by Colin Young-Pow (Optech, Inc.) using Poly Works.

Extensive forest measurements were collected between June 30 and July 12, 2002, and included tree-level measurements of tree height, height of live crown, LAI, canopy diameter (north to south and east to west), diameter at breast height (DBH), species identification, and understory characteristics. All trees with a DBH e" 10cm in the red pine plot were measured. For this analysis, the topography was removed (or 'flattened') so that trees could be compared on a flat, horizontal plane. The red pine plot obtained from the airborne LiDAR data was then divided into 5-m sub-plots and sliced, vertically, at 1-m increments to allow us to examine the changes in laser pulse reflections through the canopy.

Results and Discussion

Shadowing examples within ILRIS (ground-based) and ALTM (airborne) LiDAR data for the red pine conifer plot are illustrated for 2 sub-plots (Figures 3 a, b). In all subplots, including the 2 illustrated here, airborne LiDAR pulses are concentrated within the upper portion of the canopy, between 20 and 22 m above ground level (a.g.l.). Peaks in ground-based LiDAR data tend to occur between 18 and 20 m a.g.l. Shadowing often occurs within the ILRIS data at points above 20 m a.g.l., as is indicated by minimal pulse reflections above this height. Figures 3 a and b illustrate sharp declines in the frequency of pulses recorded in the upper portions of the canopy. ALTM data exhibit similar responses to shadowing in the mid- to lower sections of the canopy, especially around 16 m a.g.l. to the lower part of the canopy. Laser pulse omissions occur when pulse reflections are greater for one instrument than the other. In other words,

Figure 1: *Schematic diagram of airborne-based LiDAR laser pulses interacting with upper canopy foliage and shadowing of pulses within the canopy.*

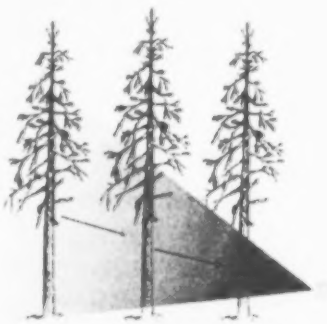

Figure 2: *Schematic diagram of ground-based LiDAR pulses hitting tree stems and lower foliage, causing shadowing within the canopy and minimal laser hits at the top of the canopy.*

where laser pulse reflections tend to occur at a particular height for one sensor, but not for another. Extreme shadowing of airborne LiDAR data at 16 m a.g.l. within the canopy likely occurs because of the converging of foliage between adjacent trees, thereby blocking some laser pulses from hitting the ground at these particular areas within each sub-plot. Sharp declines in laser pulse reflection may also be indicative of tree shape and canopy closure, where tree branches extend to a maximum diameter, thereby blocking laser reflection from branches below them.

Airborne LiDAR data tends to be shadowed within the centre of the canopy at approximately 16 to 18 m a.g.l. to the base of the canopy, and also tends to have few and scattered laser returns from tree stems. Figure 4 illustrates shadowing at the base of the canopy by measuring the height a.g.l. at a point of diminishing laser returns on the first (closest to the ground) curve found in Figure 3. The approximation of the canopy base using "sliced" airborne LiDAR data is an important biophysical parameter for determining the volume of biomass within a given area. Thus comparisons of the rising limb of these lower elevation pulse frequency curves with ground collected data may provide useful information on the ability of airborne LiDAR to distinguish between the base of the canopy and other foliage. Also, these curves may be an indicator of tree canopy extent, if the base of the canopy is not reached and is therefore shadowed by the broadest part of the canopy. Averaged ground-based measurements of canopy base for trees located within each 5m x 5m sub-plot are illustrated with height in Figure 4. Averaged ILRIS and ALTM base canopy measurements are also illustrated for sub-plots within the same figure.

Ground measured canopy base heights tend to be more closely similar to those of the ALTM than for the ILRIS, which is a positive result for those who use airborne scanning systems. Variability relationships between measurement techniques, however, are low. Thus shadowing of ALTM data in comparison with ILRIS point frequency may be more similar to that of actual ground measured tree canopy bases. Interestingly, differences in height a.g.l. between ILRIS and ground-measured data are greater than those for the ALTM. This may be related to the ability of the ILRIS to collect information on dead woody biomass in a region below the base of the live canopy, as woody biomass will reflect high resolution laser returns (not shown). On further inspection, we might find that the ILRIS system is able to differentiate between woody, dead biomass below the canopy and the base of the live canopy. These may be differentiated by examining the rising limb of high frequency laser pulse returns on a second curve or "peak" in the surrogate waveform (Figure 3 a and b).

The results indicate that shadowing within tree canopies is considerable, meaning that the canopy volume, a parameter associated with biomass and leaf area, can be underestimated. It was observed that the lowest frequency of airborne LiDAR returns occurred between 11 and 16 m above ground level. Ground-based laser-pulse returns were less influenced by shadowing due to the high

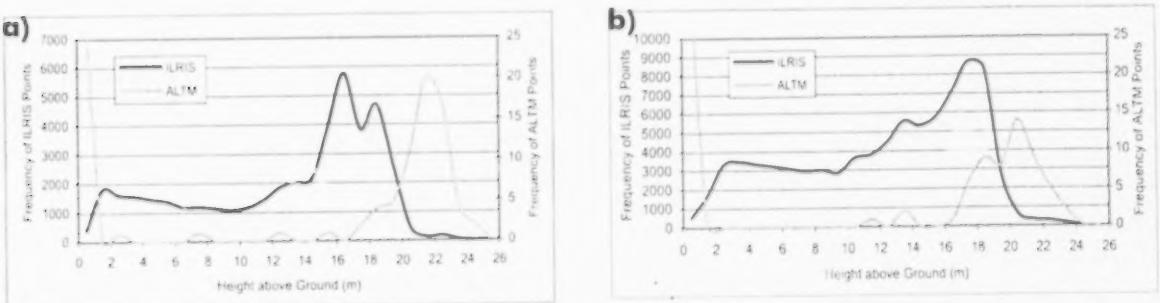

Figure 3: *Illustration of shadowing within plots for 2 sub-plots. Shadowing occurs when relative ALTM laser pulse reflected frequencies exceed those of ILRIS (mid- to upper canopy) and when relative ILRIS laser pulse reflected frequencies exceed those of ALTM (mid- to lower canopy). Frequency of laser pulse returns can be examined as a 'surrogate' waveform through the canopy.*

three-dimensional sampling resolution of the data (~1 cm). The average volume susceptible to shadowing within a 5 x 5 x 26-m column of the canopy from airborne LiDAR alone is 113.9 m^3, although this assumes that all empty spaces within the column from the base of the canopy to the top of the canopy are filled with biomass. The ground-based LiDAR system has a much lower average volume susceptible to shadowing within the 5 x 5 x 26-m section of the plot of 64.6m^3. Summary statistical analysis for the averaged 30 x 30-m red pine plot is provided in Table 1.

Conclusions

This study quantifies the laser-pulse shadowing that occurred within a managed red pine plot in Southern Ontario, and demonstrates the need for close examination of canopy volume underestimations (due to shadowing) if using vertical laser-pulse frequency distributions as a surrogate for vertical canopy structure. Through this study, it was also found that the waveform of laser pulse frequency with height may play an important role in distinguishing major tree crown features within 5-m sub-plots. As such, ILRIS tended to adequately represent dead, woody biomass, the base of the crown (as compared to ground-based measurements), the maximum radius of the crown, and possibly the top of the crown, although this was not examined directly in this study. Similarly, ALTM laser pulse frequency waveforms adequately estimated the highest biomass within 0.4 m (on average) below ground-based measurements. Although the base of the crown could not be classified, it is suspected that the greatest diameter of the crown could be estimated from the second frequency peak within the waveform. This shows promise for future structural studies on surrogate or re-created waveform analysis. Future analyses will include resampling the ALTM data to match that of the ILRIS pulse frequency, with assessment of the volume of shadowed biomass within "difference" curves.

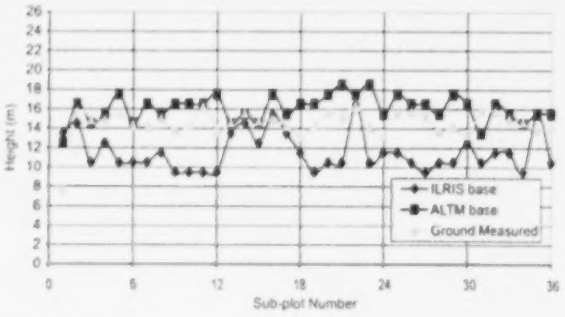

Figure 4: *Averaged canopy base height within 5-m sub-plots for both ILRIS and ALTM indicated by high frequency pulse returns at these heights. Ground measurements have also been included by averaging the height of the canopy base for all trees located within each particular plot.*

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Table 1: *Averaged summary statistics on shadowing within the 30-m red pine plantation plot and 5-m sub-plots.*

	ALTM	ILRIS	Ground Measured
Average (35 m) canopy height	23.1 m	21.5 m	23.4 m
Average (35 m) canopy base	16.1 m	11.6 m	14.6 m
Height of area shadowed (per 5 m plot)	4.5 m	2.6 m	N/A
Height at which maximum frequency of pulses occur	20.9 m	15.5 m	N/A
Volume within the column susceptible to shadow (per 5 m plot)	113.9 m	64.6 m	N/A

A Natural Disturbance Pattern Emulation Guide for Ontario, Canada

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Introduction

During the past few decades, the focus of forest management has moved from the timber provided by trees to all components of the forest ecosystem. This shift has occurred due to social expectations, economic opportunities, our increased knowledge of forest ecology and legal requirements (i.e., Ontario's *Crown Forest Sustainability Act*). Science has also suggested that the coarse and fine filter approaches to habitat management may provide better results for maintaining biodiversity than the single species-based approach currently used by Ontario (i.e., reliance on featured and/or indicator species). Using a coarse filter to manage the forest in a manner more closely resembling natural disturbances increases the likelihood that humans can maintain a sustainable forest ecosystem, with all its diversity, while simultaneously utilizing its many values.

Approach

The Ontario Ministry of Natural Resources prepared the *Forest Management Guide for Natural Disturbance Pattern Emulation* (OMNR 2001) to provide direction on how best to retain landscape patterns that emulate those created by natural disturbances. The purpose of the guide is to ensure that forest harvesting operations are planned and conducted in a manner that will maintain or enhance the current level of biodiversity in Ontario's forests.

Given the wide scope and environmental implications of the guide, a multi-disciplinary writing team was formed, with representation from the forest industry, environmental organizations, academia and the Ministry of Natural Resources (MNR). These individuals consulted with their respective colleagues throughout the development of the guide. In addition, two workshops were organized, one near the beginning of the project and the second following the completion of the second draft of the guide, to consult with a larger representation of interested organizations. Approximately 50 individuals were invited to attend each workshop. As well as the forest industry and environmental organizations, representation was sought from Aboriginal communities, trappers, prospectors, anglers and hunters, resource-based tourist operators and research scientists.

Two drafts of the document were made available for public review and comment. Each review period lasted 60 days, and approximately 1500 comments were received on each draft.

Discussion

The topic of harvesting, in particular the use of clearcuts, received considerable interest and discussion during the four years of public hearings on MNR's proposed environmental assessment of timber management. The Environmental Assessment (EA) Board's decision (EA Board 1994) recognized the clearcut silvicultural system as a valid management technique in Ontario, especially in the boreal forest, but included some conditions on its continued use. The EA Board acknowledged the need for a range of clearcut sizes similar to that created by natural disturbances, but noted that society's concerns with this type of harvesting meant that clearcuts should not exceed 260 ha, except for sound silvicultural or biological reasons. The Board's decision did not provide examples or clarification of what those reasons might be, nor

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did it place a limit on the number or percentage of clearcuts that could exceed the 260 ha size. The Board also required MNR to create a forest management guide that would provide more information and direction on the topic of clearcut size, shape, and placement (Term and Condition 27).

Shortly after the EA Board decision was released, the Ontario government passed a new act that determined how the province's Crown forests were to be managed, the *Crown Forest Sustainability Act, 1994* (CFSA). One of the principles of this act was to use "... forest practices that, within the limits of silvicultural requirements, emulate natural disturbances and landscape patterns ..." (CFSA, s. 2(3)). Thus, not only was there a legal requirement to create a guide, the direction that the guide must include (i.e., the emulation of natural disturbances) was also enshrined in law.

Meanwhile, our improved understanding of the complexities of sustainably managing forest ecosystems suggested that the emulation of natural disturbances would be a key component of a coarse filter at the landscape and stand scales. This would not only provide wildlife habitat for a broad range of species, it would also help maintain other aspects of the forests' biodiversity.

The authors of the guide attempted to find an appropriate balance for these different components; i.e., society's concerns with large clearcuts; nature's reliance on a range of disturbance sizes, from very small to very large; legal direction; and the practicality of implementing the guide. The document provides direction at landscape and stand scales, as well as guidance on silvicultural practices that emulate natural disturbance patterns.

Landscape Historical fire patterns suggest that most disturbances are very small, with only a few very large fires. The area disturbed, however, is the exact opposite, with most area included in the few large fires and relatively little area accounted for by the many small ones. The guide requires forest management planners to establish a complete range of cutblock sizes, from small to large, that is similar to the natural historical pattern, with a limitation that, in the boreal forest region, no more than 20% of the cutblocks can exceed 260 ha. In the Great Lakes-St. Lawrence forest region, where larger natural disturbances are not as common, no more than 10% of the planned cutblocks can exceed 260 ha.

There is no upper limit on the size of large clearcuts; rather the size of the large cutblocks is determined by a number of factors that are specific to each individual forest management unit. While the total area that is available for harvest in a given year (the Allowable Harvest Area) has not changed, the distribution of this area will be different than what would occur prior to the development of this guide. The requirement to create a full range of cutblock sizes, of which no more than 20% (or 10%, depending on the forest region) can be larger than 260 ha, begins to restrict the size of the largest cutblock. In each administrative district, the Local Citizen's Committee, a public group that provides advice to the forest management planning team and the District Manager, can also provide an indication of the maximum size of cutblock that the local public is willing to accept.

The guide also provides direction on the spacing of the various cutblocks. Generally, the larger the cutblock, the further away it must be placed from a cutblock of similar size.

This landscape direction permits forest management planners to create cutblocks and place them on the landscape in a manner that reflects nature, helps maintain the forest's biodiversity, quantifies some of the legal direction from the EA Board and respects the public's concerns about large clearcuts.

Stand The direction to use the emulation of natural disturbances as a coarse filter also applies at the stand (or multi-stand) level. Patches of living trees (10-36% of the cutblock

area, depending on the susceptibility of the forest type being harvested to fire) are left within the boundaries of the cutblock. In addition, an average of 25 individual standing trees, both living and dead, are left on each hectare of the harvested area. These residual trees, both patches and individuals, are intended to resemble the material remaining after a wildfire, and provide structural diversity to the cutblock. In the short term, this vertical diversity provides habitat for a number of wildlife species; in the future, the downed wood debris will be utilized by other wildlife species and ecological processes.

Silviculture Some general advice is also provided on some silvicultural techniques that emulate natural disturbances and that should be considered during forest management planning. These include prescribed burns for site preparation; harvest methods that promote uneven-aged stands, similar to that produced by fires of light intensity; promoting natural or assisted natural regeneration whenever appropriate (ecologically and economically); and minimizing the harvest of unburned areas within salvage operations.

Conclusion

This guide addresses a controversial subject, namely the harvesting of forests under the clearcut silvicultural system. Not surprisingly, the document itself became controversial and the subject of considerable interest by the public and the media. Its completion was possible only with substantial input from the public and affected parties, and with the support of senior government officials. There are still many unknowns about the use of forest management to emulate natural disturbance patterns, and this guide must be viewed as a working hypothesis, representing the current state of our knowledge. The effectiveness of the guide will be monitored so that improvements can be made to future versions, as our understanding of forest ecosystems continues to grow.

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Notes

Emulating Natural Forest Landscape Disturbances – Policy to Practice with the NDPEG Tool

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Ontario's Forest Policy Context

Over the last several decades the shift in forest management in Ontario has moved from a timber-only paradigm to the current paradigm, which includes considering landscapes and their inherent ecological pattern, composition, and functions. This shift has occurred due to social expectations, increased knowledge of forest ecology, and legal requirements (i.e., Ontario's *Crown Forest Sustainability Act*).

Science suggests that the coarse- and fine-filter approaches to landscape management may better address biodiversity concerns as compared to a single species-based approach. The current hypothesis is that by using a coarse filter to manage forest landscapes in a manner that more closely resembles natural disturbance regimes, the likelihood of maintaining a sustainable forest ecosystem with all its diversity is increased. The Ontario Ministry of Natural Resources prepared the *Forest Management Guide for Natural Disturbance Pattern Emulation* (OMNR 2001), referred to here as NDPE Guide, to direct how best to retain landscape patterns to emulate those created by natural disturbances. The purpose of the guide is to ensure that forest harvesting is planned and conducted in a manner that will maintain or enhance biodiversity in Ontario's forests. This is accomplished at the landscape level by using a range of disturbance sizes, similar in area and frequency to historical natural wildfires (i.e. many small fires, some middle-sized fires, a few large ones). At the stand scale, individual standing trees and patches of living trees will be left within the boundaries of both individual cutblocks and disturbances made up of multiple cutblocks and burns to resemble the post-wildfire residuals.

From Policy to Practice – Forest Management Planning Challenges

Moving from policy to practice presents challenges to forest management planners, including interpretation of policy intent and policy spirit, planning options and reporting requirements. A fundamental requirement is the ability to classify, inventory, and visualize harvest patterns to allow interpretation and scenario development at the forest management planning stage. The NDPE Guide requires planning of forest harvest and retention activities at a minimum of 2 scales: landscape disturbance event and within harvest blocks. In addition, these planning activities must be integrated within the current analysis framework of forest management. We developed an Arcview GIS-based landscape analysis tool to assist in implementing Ontario's NDPE Guide. Our goal in this presentation is to demonstrate how a landscape analysis tool can provide the foundation of transfer of policy to practice in forest management planning.

The Natural Disturbance Pattern Emulation Guide Tool

The NDPE Guide Tool operates as an extension to ESRI's Arcview GIS. It is programmed in Arcview's Avenue language and uses both shape and coverage file formats.

Buse, L.J. and A.H. Perera (comp.). 2003. Meeting emerging ecological, economic, and social challenges in the Great Lakes region: Popular summaries. Ont. Min. Nat. Resour., Ont. For. Res. Inst., Sault Ste. Marie, ON. For. Res. Inf. Pap. No. 155.

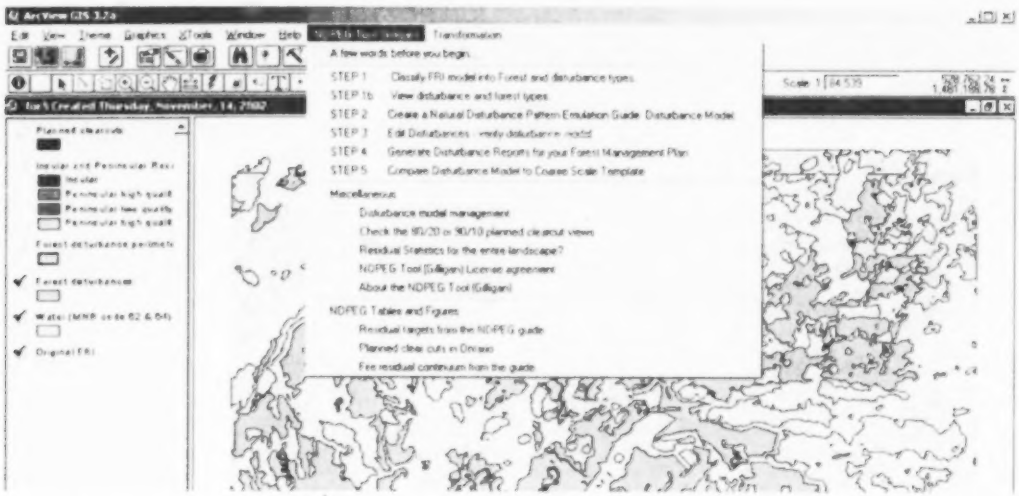

Figure 1. *Natural disturbance pattern emulation guide (NDPEG).*

The primary data source used is the Forest Resource Inventory (FRI), a polygon-based spatial forest inventory. The importance of data preparation cannot be overstated – the tool assumes that all polygons of the forest inventory are up-to-date with the following attribute information: *forest unit, stand stocking, stand height, and years since last depletion.*

The NDPE Guide Tool can be applied either top down or bottom up. For purposes of explanation, we will describe its application as bottom up. The extension, once loaded into Arcview, creates a new menu item in the view window under which a step-by-step list of suggested actions are presented. These actions facilitate FRI classification, disturbance model creation, disturbance model verification and editing, landscape scale disturbance analysis and reporting features.

A primary result of an analysis using the NDPE Guide Tool is what we refer to as a disturbance model. The disturbance model is a direct application the NDPE Guide standards and guidelines (planning regulations) for a specific management area for a specific point in time. Each disturbance model identifies unique disturbances according to Ontario's definitions of both clearcuts and forest disturbances as defined in the NDPE Guide. Within each disturbance, 2 types of forest residual patch are identified and enumerated: insular patches not connected to forest outside the disturbed area and peninsular patches that are connected to the forest matrix. Placements, size, shape, and composition of these patches in relation to the harvested areas is the focus of the NDPE Guide application. The NDPE Guide Tool contains an editing module that allows planners to select and zoom to any disturbance and view and modify disturbance components. This editing module can also be used to plan and evaluate future harvest patterns. The NDPE Guide Tool provides forest planners with a quick and repeatable means of determining how to meet the NDPE Guide standards and guidelines and/or determine achievement. Although the tool was developed specifically for the guide, it also includes options to change the disturbance parameters that are defined in the guide.

At the landscape scale, the NDPE Guide requires planners to place a variety of sizes of disturbances across the landscape to attempt to emulate the placement and frequency of wildfire. The NDPE Guide Tool contains Ontario' fire history from 1920 to present. It allows planners to compare the patterns of their forest management area to an ecologically based

(ecoregions or combinations of ecodistricts) selection of historic fires to evaluate how well they are emulating the pattern of wildfires across the landscape.

Although the tool was designed specifically to assist with the implementation of the NDPE Guide, it allows user specification for clear-cut definitions, green-up periods, and adjacency rules. The tool comes pre-loaded with fire history information for Ontario, which can also be substituted for similar information from other jurisdictions.

To date we have trained over 200 forest planners in the use of the NDPE Guide tool. To our knowledge, it is the only GIS-based tool capable of the implementing the planning and reporting requirements of the NDPE Guide. It is available for download from the internet at www.sfmmstuff.com (username MNR, password 42).

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Notes

Roles of Selection Cutting, Fertilization and Competition Removal on the Density, Growth and Survival of Sugar Maple and Yellow Birch Seedlings

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Introduction / Objectives

The sugar maple (*Acer saccharum* Marsh) and yellow birch (*Betula alleghaniensis* Britton) forest type is an important component of the forest ecosystem in the Great Lakes-St. Lawrence forest region for its ecological, economic, and social values. Innovative silvicultural prescriptions are recommended to manage this forest ecosystem sustainably. It is pertinent to assess the validity of these interventions and consider their repercussions on the competitiveness of each species under different silvicultural situations. Selection cutting presumably emulates the natural disturbance regime and natural patterns of vegetation. Fertilization counterbalances the depletion of exchangeable cations due to acid precipitation. Competition removal assumingly increases growth and survival of commercial species. A field experiment was set up to test separately and simultaneously the effect of these 3 treatments on the regeneration of sugar maple and yellow birch.

Approach

The study site is located in the Réserve faunique de Portneuf in Rivière à Pierre, Qc (47°04'N, 72°15'W; 375 m a.s.l.) and has a surface area of 40 ha. The canopy is dominated by sugar maple, yellow birch, and American beech (*Fagus grandifolia* Ehrh.). The soil is an Orthic Humo-Ferric Podzol on an undifferentiated till approximately 1-m deep. Mean annual precipitation is 1220 mm, and mean minimum and maximum temperatures range from -12°C in January to 28°C in July (Ricard 1999).

Three sizes of gaps were created by single-tree and group-selection cuttings in autumn 1996. Small gaps are approximately 50 m^2. Medium and large gaps range from 100 to 300 m^2 and from 700 to 1200 m^2, respectively. A mixture of lime (equivalent to 500 $kg.ha^{-1}$) and potassium chloride (equivalent to 25 $kg.ha^{-1}$) represent the fertilization treatment. A third treatment, competition removal was created. Fertilization and competition removal were applied at 2 levels: absence or presence. These 3 treatments were crossed according to a factorial design (3 X 2 X 2 = 12 combinations). These 12 combinations were replicated 12 times. Six years after treatments, seedling density was determined and height and annual leader increment were measured. Survival of approximately 1500 seedlings of both species was followed for 42 months since autumn 1999.

A 3-way ANOVA and Tukey HSD multiple comparison test were applied to the density and growth data. The product-limit method (Kaplan-Meier) was used to perform survival analysis. An ANCOVA was carried out to compare the response of growth to gap size between the species. Significance level was set at $p = 0.05$.

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Results

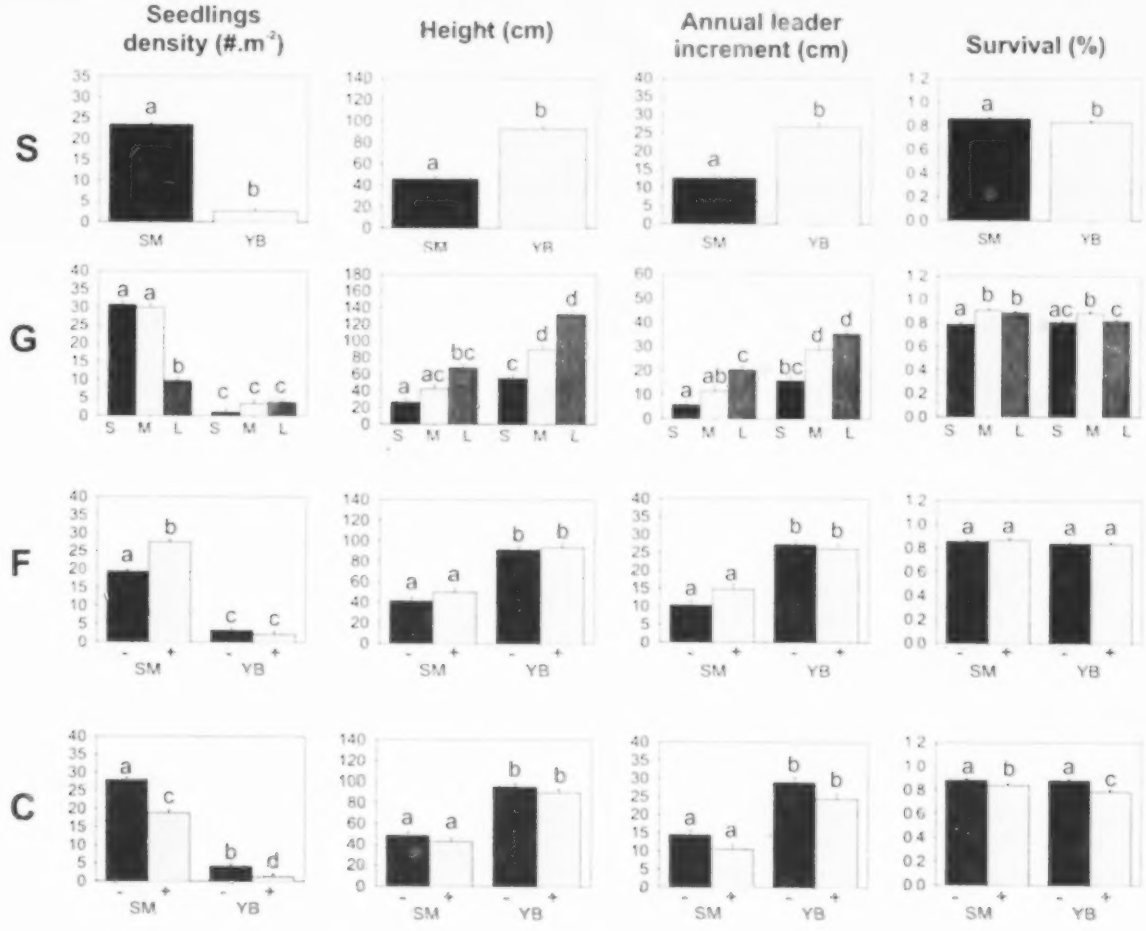

Figure 1. *Effect of species (S), gap size (G), fertilization (F) and competition removal (C) on the density, height, annual leader increment and survival of sugar maple (SM) and yellow birch (YB) seedlings. Errors bars show +/- 1 SE. Different letters designate significant differences between species and treatment at $P < 0.05$. S, M, L refer to small, medium and large gaps, respectively; - and + refer to absence or presence of treatment.*

Sugar maple always had denser regeneration and better survival than yellow birch, while yellow birch consistently grew better. With increasing gap size, the density of sugar maple dropped whereas that of yellow birch increased slightly but not significantly. The growth of both species responded differently to the gradient of gap size: yellow birch growth was more sensitive to gap size than sugar maple (ANCOVA, $P < 0.05$). However, gap size did not generate differences in the survival of the 2 species, except in large gaps where mortality of yellow birch seedlings was slightly superior to that of sugar maple. The only significant effect of fertilization was to increase the density of the sugar maple seedlings. Competition removal considerably decreased seedling density and to a smaller extent the survival of both species (Figure 1).

Gap size interacted with the fertilization or competition removal treatments to determine the density of sugar maple seedlings. The effect of fertilization on the height of yellow birch

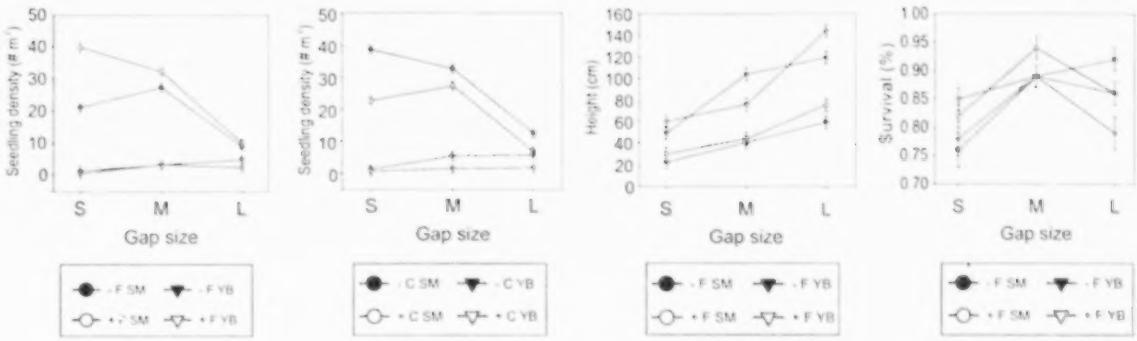

Figure 2. *Significant interaction effect of gap size and fertilization on the density (A), on height (C) and survival (D) of sugar maple (SM) and yellow birch (YB) seedlings. Significant interaction effect of gap size and competition removal on the density of sugar maple and yellow seedlings (B) ($P < 0.05$). Errors bars show +/- 1 SE; - and + refer to absence and presence.*

seedlings depended on gap size. Survival of sugar maple and yellow birch seedlings was explained partly by the interaction of gap size and fertilization (Figure 2).

Discussion and Conclusion

This study suggests that after the early establishment phase (i) yellow birch seedlings are growing and surviving well, (ii) gap size plays an important but complex role in relation to the fertilization and competition removal treatments, (iii) low-level fertilization, as applied in this study, is not a pertinent silvicultural practice as it did not significantly improve growth or survival, (iv) competition removal has a negative effect, presumably due to the increase of moisture stress, and (vi) medium gaps represent a good trade-off to regenerate both species as they optimized survival without sacrificing too much growth.

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Acknowledgements

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Notes

Assessing Plot-level Forest Metrics with a Ground-based Scanning LiDAR

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A ground-based scanning LiDAR system was evaluated to assess its potential utility for automated forest mensuration data extraction. Two plots were investigated in depth; a red pine conifer plantation and a deciduous stand dominated by sugar maple. Five LiDAR point cloud scans were centred on each plot over a 6-hour period on July 5th 2002 using an Optech Inc. ILRIS 3D laser imager, and subsequently analysed in the *Innovmetric* "Polyworks" software suite. Ground truth data were manually collected over several days during the same time period as the LiDAR survey for subsequent comparison. There were more than 130 trees in both plots and the following parameters were derived from the LiDAR data:

- Stem location
- Stem density
- Tree height
- Stem diameter at breast height (DBH)
- Crown diameter
- Timber volume

All parameters could be measured or estimated using the ILRIS 3D imager. There was a slight systematic underestimation of mean tree height resulting from canopy shadow effects and sub-optimal sampling distribution. Timber volume estimates for both plots were within 7% of manually derived estimates. The first 4 parameters listed above can potentially be measured objectively with little manual intervention. However, locating and counting trees in the multi-tiered deciduous plot required more subjective interpretation than in the pine plantation. Individual tree crown diameter estimates could not be estimated objectively in this study but subjective estimates of crown diameter using ILRIS data are probably at least as good as the equally subjective manual field measurements.

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Notes

Effects of Fine Sediment Inputs from a Logging Road on Stream Insect Communities

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Introduction/Objectives

One of the challenges in addressing forest sustainability objectives is scientifically determining the ecological implications of anthropogenic disturbances to the forest environment. Logging activity, and particularly the road construction associated with it, can result in degradation of aquatic habitats through fine sediment inputs to streams and siltation of stream beds. The biological consequences of sedimentation in streams can include perturbations to benthic insect communities resulting in declines in abundance and (or) changes in community structure. However, most studies that have examined the effects of fine sediments on stream insect communities have relied on small-scale manipulative approaches in artificial stream channels or flumes, on comparative studies between reference and sediment-impacted sites after the disturbance, or on comparisons along a gradient of sedimentation. These provide useful information on the potential for effects of sedimentation on stream insects, but may not be representative of real-world responses by benthic insects to fine sediment inputs because of limitations in scale and the lack of baseline or pre-disturbance community measures.

Effects of fine sediments on stream insects from logging activity have been reported from field monitoring studies, but the negative impacts on benthos may have been confounded by other catchment disturbances such as canopy modification or changes in nutrient flux. We conducted a stream manipulation study to examine effects of fine sediment inputs on stream insect communities, and focused on time trends over pre-disturbance and post-disturbance periods with comparisons to a nearby reference stream. This approach integrated the realism of a natural stream study with the experimental control of a manipulative study by including pre-sedimentation measurements to establish baseline trends, and by excluding other catchment disturbances. The objective was to determine the impacts on stream insect communities of fine sediment inputs at a magnitude that could occur from an active logging road.

Approach

A road crossing over a forest headwater stream was amended (gravel road surface upgraded, road-side ditches cleared) to induce fine sediment inputs to a stream reach. Sediment bed load in the study reach and at a nearby reference stream was quantified before and after the manipulation by extraction of fine sediments from core samples. Aquatic insect communities were sampled in spring and fall for 2 years before and 3 years after the sediment inputs, and compared to insect communities at the reference stream. Quantitative sampling was conducted with modified (increased size, 0.32 m^2) Suber-type samplers, n=10, over 120-m study reaches. Insect community structure was compared between the sediment site and the reference stream before and after the disturbance by multivariate ordination (nonmetric multidimensional scaling), multivariate analysis of similarity, and by time series analyses of univariate community metrics (repeated measures orthogonal polynomial coefficient analysis). Divergence in trends over time at the sediment and reference sites and (or) significant time X treatment interaction in the repeated measures analyses were considered evidence of treatment effects.

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Results and Discussion

Fine sediment bed load at the manipulated site increased from a pre-disturbance average of about 800 g m^{-2} to over 5000 g m^{-2} that persisted for over 2 years. Fine sediment inputs were 97% inorganic and about 80% of the particles were in the coarse silt (40-63 µm) size range. This resulted in an average stream-bottom sediment coverage of 46.7%, compared to a fine sediment coverage of 14.5% in the reference stream by the end of the study period.

Despite these increases in fine sediment bed load at the manipulated site, only small changes in aquatic insect community structure could be detected. No obvious patterns to suggest sediment impacts and no significant differences in time trends between the sediment and reference sites were detected for total insect abundance or biomass. An examination of community structure by multivariate ordination (NMDS) demonstrated that over the 5-yr study period there were generally greater differences between sites than among years, but that these differences were as large or larger before the sediment inputs. This occurred despite the similarities between these paired sites in catchment size, stream widths, study reach lengths and orientation, forest composition, canopy structure and density, environmental influences (given the proximity of sites), and substrate characteristics. The distinct natural differences in community structure of these paired streams underscores the need for establishing baseline or pre-treatment conditions to which after-impact conditions can be compared in unreplicated, whole-stream experiments such as this one. A paired-stream comparison after the disturbance would have indicated distinct differences in aquatic insect community structure, suggesting a marked effect of sedimentation on benthic insects, but it is clear that distinct differences in community structure in these streams were present before the disturbance. The patterns in community structure over time illustrated by the ordination plots showed only subtle divergence in trends between sites after the disturbance.

Among the univariate metrics examining spring and fall communities at the sediment and reference sites (16 time series analyses in total), six gave evidence of a sediment impact on community structure. Of those, the clearest indications of an effect on community structure were small reductions in diversity and richness of spring communities (Figure 1). These were primarily the result of a decline in the proportion of spring shredders (insects feeding on leaf material) after the disturbance, accompanied by a significant increase in the percent Chironomidae (Figure 2). None of these community metrics gave evidence of a sediment impact on fall communities.

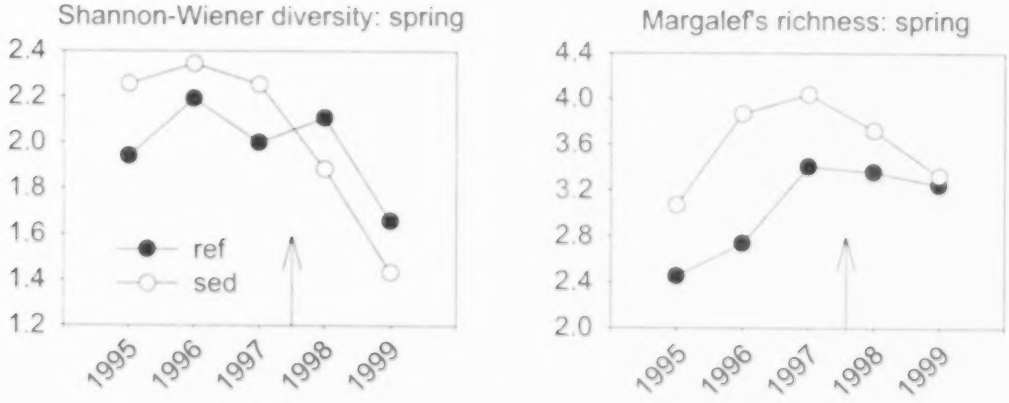

Figure 1. *Average insect diversity and richness indices based on spring samples. Arrows indicate sediment inputs.*

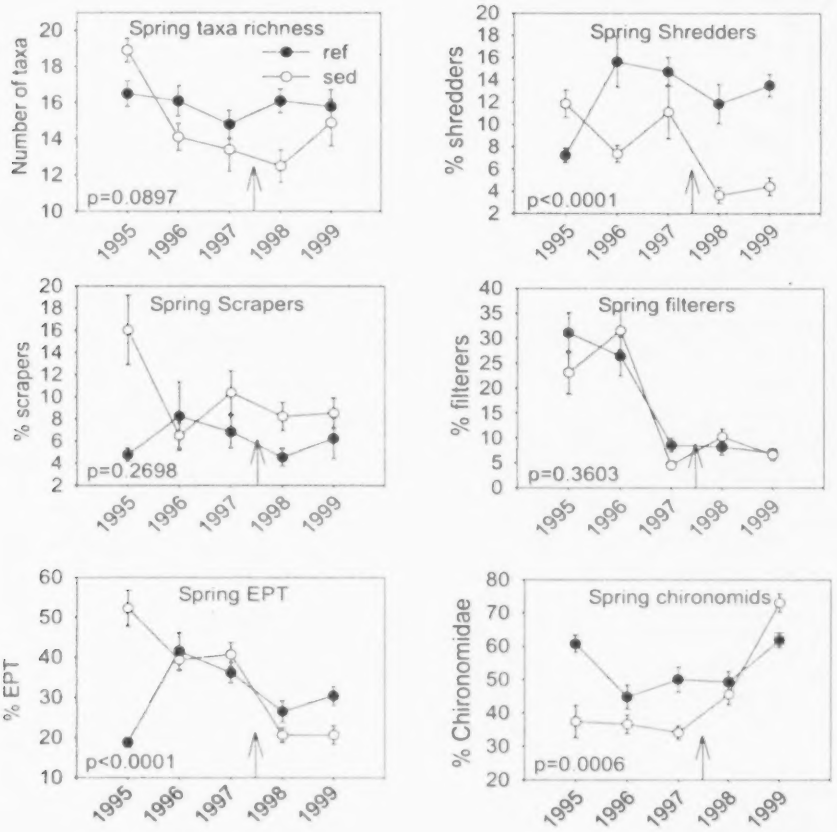

Figure 2. *Average insect community metrics in spring samples. Arrows indicate sediment inputs, p values are for time X treatment interaction terms.*

Conclusions

Despite large and sustained increases in fine sediment bed load (about 7-fold increase for 3 yr), only small changes in aquatic insect communities were detected. The insect community exhibited a high degree of resistance to fine sediment deposition of this magnitude. No effects on total insect abundance, biomass, or 10 of 16 community metric analyses were observed. A significant decline in the proportion of spring shredders (aquatic insects that feed on leaf material) may have resulted from reduced quality of food resources through siltation of benthic organic matter. An increase in the proportion of spring chironomids reflects their general tolerance of sediment-degraded habitats.

The large-scale experimental approach of this study integrated the realism of a whole-stream study with the experimental control of a manipulative study by including pre-sedimentation measurements and excluding other confounding catchment disturbances. In this regard, it may provide a more realistic measure of community-level effects on benthic insects of sedimentation at a magnitude that might be associated with logging activity, than most previous studies.

Notes

Integrating Ecological, Economic, and Social Information to Manage the Chippewa and Superior National Forests, USA

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To respond to public needs and desires and to manage ecosystems to provide for long-term sustainability, the U.S. Forest Service is integrating ecological, economic, and social information to revise Forest Plans on the Chippewa and Superior National Forests. The Forest Service mission is to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations. To take on this challenge, the Forest Service uses ecosystem management as an operating philosophy (Overbay 1992). Ecosystem management is scientifically based land and resource management that integrates ecological capabilities with social values and economic relations to produce, restore, or sustain ecosystem integrity and desired social conditions, uses, products, values, and services over the long term. Forest plans are strategies for locally implementing ecosystem management.

Forest plans establish management direction for a national forest. They describe desired resource conditions, preferable management practices, limits on management, levels of resource production, and the amount of land that will be managed for timber. The National Forest Management Act requires that forest plans be revised every 10 to 15 years. In Minnesota, the Chippewa and Superior National Forests are nearly finished with a joint forest plan revision process. The Forest Service has developed proposed management direction at 3 levels: on a forest-wide basis, by "Landscape Ecosystem", and for "Management Areas".

Landscape Ecosystems are derived from a combination of individual or groupings of native plant communities, ecological systems, and Terrestrial Ecological Unit Inventories at the Land type Association scale and at the Ecological Land type scale, using the Forest Service's National Hierarchical Framework for Ecological Units (Bailey 1995, ECOMAP 1993). Each Landscape Ecosystem is characterized by its dominant vegetation communities and patterns, which are a product of local climate, glacial topography, dominant soils, and natural processes, such as succession, fire, wind, insects, and disease. The Forest Service used several the work of several authors to describe the composition, structure, and function of the Landscape Ecosystems of the Northern Minnesota Drift and Lake Plains Section and of the Northern Superior Uplands Section (Heinselman 1996; Shadis 1997; Almendinger and Hanson 1998; Frelich 1999, 2000; White 2000; Rusterholz 2002). Information about Landscape Ecosystems is being used for evaluating inherent capability of resources, predicting changes over time, evaluating effects of management strategies, allocating land to Management Areas, and discussing and analyzing ecosystems and biological diversity at multiple scales. The Forest Service developed objectives for the vegetation in each Landscape Ecosystem. These objectives are for composition in terms of forest type, tree species diversity, and age class.

Both of the National Forests are divided into Management Areas. This is like zoning in county or city planning. Examples of Management Areas are 'Research Natural Areas' or 'Longer Rotation Emphasis Areas'.

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Complimenting Landscape Ecosystem objectives, management direction for each Management Area identifies which tools and techniques to use to reach the desired conditions for natural resources, including the Landscape Ecosystem objectives. Direction for Management Areas establishes the desired infrastructure for an area, such as recreational facilities and roads, it also outlines the opportunities in the area in terms of timber, scenery, research, wilderness, and other resources. The Forest Service integrates ecological, social, and economic information by overlaying Management Areas and Landscape Ecosystems.

A Draft Environmental Impact Statement (EIS) analyzes different combinations of Management Areas, called alternatives. Alternatives vary in which Management Areas are emphasized and how the Management Areas are spatially arranged across the Forests. (Landscape Ecosystem boundaries are spatially fixed and do not vary by alternative; however, the vegetation objectives do vary by alternative.) In collaboration with stakeholders, an interdisciplinary planning team developed and mapped 7 alternatives that address 21 key resource issues. The Forest Service worked with the public to identify resource issues early in the revision process.

Indicators highlight differences among the alternatives and help summarize the environmental, economic, and social impacts of the alternatives. In the Draft EIS, each issue has one or more indicators that describe existing conditions and estimate potential effects of management activities. Generally, indicators are quantitative, but some are qualitative. For example, the following were analyzed for all seven alternatives: timber sell volume, using million board feet, large mature/old upland forest patches, using acres and number of patches, changes in community social factors, using social attitudes, values, and beliefs to describe the human dimension of natural resource management.

The Forest Service collaborated with other land management organization and other agencies to collect the ecological, social, and economic information that was analyzed in the Draft EIS. Social and economic assessments are some of the tools the Forest Service uses to better understand attitudes, values, and beliefs of individuals, tribes, local communities, regional areas, and national interests. For Forest Plan revision, the Forest Service contracted two regional development commissions do social and economic assessments. The Headwaters and Arrowhead Regional Development Commissions compiled socio-economic information in the context of counties surrounding the Chippewa and Superior National Forests. They used a variety of techniques to gather information, including a survey mailed to randomly selected local and regional people, focus groups, primary and secondary survey data, and key informant interviews. The assessments provided information about supply and demand trends that affect the National Forests, including vegetative resource use, recreational and leisure use, and development and demand for facilities and programs. Assessments also described the current situation or existing condition, detailing such activities as sites that are important for cultural and traditional uses, and an individual's sense of place.

Other major land management organizations in northern Minnesota are also analyzing their management in terms of the effects on ecosystems. The Chippewa and Superior National Forests are involved in the Landscape Ecosystem Management approach developed by the Minnesota Forest Resource Council through the Northeast and North Central Minnesota assessment groups. We recognize that what happens on National Forest land affects other ownerships that are interspersed within and around the National Forests. We are coordinating our planning efforts with these other parties. In addition to working with the Minnesota Forest Resources Council, the Chippewa and Superior National Forests are also coordinating with other National Forests in the region that are revising their forest plans.

The Minnesota Forest Resources Council chartered a panel of experts to define the range of natural variability for forested communities in northern Minnesota. The concept of the range of natural variability as a reference condition for analysis was used to compare and evaluate the ability of the National Forests to contribute to a healthy landscape condition. Conserving and restoring diverse ecosystems and landscapes requires maintaining habitats for the majority of species and thus improve the possibilities for conserving biological diversity at all levels (Hunter et al. 1998, Hunter 1999). When selecting a final alternative for Forest Plan revision, the decision maker will consider analysis of ecological sustainability along with a similar analysis of the economic and social sustainability that the alternatives offer. It is not the expressed goal of future Forest Service management to completely restore the forested landscapes to the conditions that occurred when these landscapes operated within the range of natural variability. However, the information derived from a better understanding of these conditions provides a more complete context for analyzing and managing these landscapes in a more ecologically sustainable way.

Sustainability is a cornerstone of the National Forest Management Act, and it continues to be the essence of Forest Service land and resource management. The Draft EIS analyzes the potential effects of different management strategies on key components of ecological, social, and economic sustainability. The decision maker will consider all this information in selecting an alternative for the final revised Forest Plans.

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Notes

Developing Sustainable Forestry in Michigan: Managing the Red Pine Resource in Michigan's State Forests

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Introduction

Red pine *(Pinus resinosa)* comprises a little over 7% (110,000 ha of 1,540,000 ha) of Michigan's State Forest lands. A number of factors associated with this resource have made it the focus of a current project by the Michigan Department of Natural Resources (DNR). As in several other northeastern states, red pine is concentrated on public lands and has a very skewed age class pattern due to government-sponsored planting programs in the 1930s and late 1950s through early 1960s. Much of the resource is or will be economically mature in the coming decade, but differences of opinion exist with respect to how the resource should be managed. In particular, decisions about where and how much of the resource to regenerate have been stymied due to concerns about tradeoffs between wildlife and ecological values versus managing densely stocked, pure stands for the best financial returns. All of these factors point to a need to sort through issues and assess how the resource should be managed both in the near term and for the long run.

In April 2002, an interdisciplinary team of Michigan DNR resource managers was charged with developing red pine management and regeneration guidelines. Their analysis was to take into account social, economic, and ecological values and a component of it was to be a landscape-level, ecosystem-based assessment. While their work is not complete as of early 2003, the approaches used and several preliminary products from the analysis can be described. Among these are assessing ecological suitability through extrapolating habitat types from soils and circa 1800 data; demonstrating an integrated balancing of factors through a multi-objective, multi-criteria approach; the development of Web-based spatial suitability information; and recommendations for management guidelines linked to inventory and suitability information.

Approach

Components of the ecological suitability analysis included examination of General Land Office (GLO) circa 1800 data previously digitized by the Michigan Natural Features Inventory, forest health data, wildlife data, and the development of a GIS-layer of habitat types based on soils data linked to the Kotar habitat classification system (Kotar and Burger 1996). Soils data have been used to develop preliminary habitat maps for most of Michigan's northern lower peninsula. An extension of this process aggregated habitat types into Landscape Management Units (LMUs) that may serve as a basis for broad ecoregional management guidelines.

The ecological suitability information was combined with economic and social information in a Multi-Objective/Multi-Criteria (MO/MC)-based Decision Support System (DSS). Web-accessible maps were developed that make the GLO, habitat type, current vegetation inventory, and other data readily available from the stand

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level up through a landscape level to the ecoregional and peninsula level.

Using information developed and attributes from current inventory data, 9 distinctive management alternatives (see box) and associated criteria were developed for the Atlanta Forest Management Unit, a 105,000 ha area in the northeastern portion of Michigan's lower peninsula (see box). Examples of inventory attributes considered include current stand composition and understory data. Following discussions of these alternatives and the areas corresponding to them, similar management alternatives will be developed for other Management Units.

Estimates of area meeting the criteria have been estimated and are being reviewed.

Discussion

The Kotar classification system focuses on the identification of repeatable patterns in the composition of forest floor vegetation. Areas sharing the same habitat type contain similar ecosystems due to similar soil nutrient and moisture regimes regardless of overstory characteristics. Habitat types are identified independent of overstory characteristics, which can vary greatly depending on the past management and disturbance history of a region. Assessing the potential of a particular site can be accomplished more easily and often more accurately than using traditional means such as site index measures. In addition, the forest habitat types provide information about tree species occurrence and composition and potential successional pathways.

Although forest habitat type identification is typically accomplished by examining understory vegetation characteristics, habitat types can also be inferred based on soil moisture and nutrient regimes found at any particular location. This relationship results from individual habitat types having specific moisture and nutrient requirements. The presence of high resolution soil type maps for northern Michigan, produced by the USDA's Natural Resources Conservation Service, provided the opportunity to generate maps depicting the spatial extent of each forest habitat type found across the region. In a Geographic Information System (GIS), soil maps from the Soil Survey Geographic (SSURGO) data base were overlayed on the original plot network set up by Kotar and Burger, identifying each soil type and the forest habitat class or range of classes that occur on a particular soil type. Additional fieldwork was conducted where plot data was lacking.

A land cover map generated from the General Land Office (GLO) surveyors' notes by Michigan Natural Features Inventory (MNFI), was overlayed with Kotar and Burger's original forest habitat type plots within a GIS system to examine the correspondence between the historical extent of forest types and land suitability classes. The results indicate the circa 1800 forest communities mapped by MNFI correspond well with Kotar and Burger's habitat types. This was expected, as the habitat types

Red Pine Management Alternatives Proposed for Atlanta Forest Management Unit

- Maintain Red Pine Using "Classic" Red Pine Management
- Convert to Red Pine/Other Mesic Conifer Mix
- Convert to "Natural" Red Pine management from "Classic" Management
- Convert Aspen/Oak to "Natural" Red Pine
- Convert Red Pine to Aspen
- Set aside existing Red Pine for "Biodiversity"
- Convert Red Pine to Jack Pine, Barrens/ Grassland
- Convert Red Pine to Northern Hardwoods
- Convert Red Pine to White Pine or mixed White Pine/Red Pine

provide a window into the past by depicting forest habitat potential. Once Kotar and Burger's forest habitat types were depicted spatially, the extent of regions suitable for red pine growth were identified for this project.

The forest habitat type system, as developed by Kotar and Burger, is used as a basis for the red pine silvicultural recommendations because of its ecological relevance. The forest habitat types described by Kotar and Burger for northern Lower Michigan span a wide range of soil nutrient and moisture regimes, with PVCd occupying the lower end (relatively low nutrient and moisture content) and AFOCa the high end. Each habitat type has its own unique, ecological signature and therefore it is appropriate that management guidelines take these differences into account. To ensure that common goals are met at the larger landscape or ecoregional level, Landscape Management Units are proposed to guide management choices. Each LMU is derived by identifying the dominant forest habitat type(s) that occur within a region defined by the State Soil Geographic (STATSGO) database.

Conclusion

The approaches and tools developed through the red pine project reflect an intent to advance sustainable forestry practices and will also be useful in addressing other issues. In particular, it is believed that there is substantial promise in using digital soils data to extrapolate suitability information for vegetation management. Another major opportunity being demonstrated through this project is use of the internet for displaying and sharing spatial data related to sustainable forestry. Future applications include the examination of other State/Forest cover types, assessment of spatial biodiversity goals, and provision of ecological suitability information to private land owners.

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Notes

To Emulate Natural Forest Disturbance or Not?

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The emergence of emulating natural forest disturbance (ENFD) as a forest management paradigm has caused resource managers to ask many questions about its appropriateness and associated mechanisms. We provide an overview of the logic behind ENFD including a working definition, and highlight some aspects of its practice and future.

When is it appropriate to emulate natural disturbance in forestry?

Emulating natural disturbance as a forest management approach is suited for ecosystems that are disturbance-driven; for example, fire-driven boreal forests, fire-driven montane forest savannas, and flood plain forests. These ecosystems are expected to be inherently resilient to periodic disturbance and are able to adapt and recover (Figure 1). Here *resilience* implies the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes and persist (Holling 1973).

Our working definition for ENFD is: *Emulating natural disturbance is an approach in which forest managers develop and apply specific management strategies and practices, at appropriate spatial and temporal scales, with the goal of producing forest ecosystems as structurally and functionally similar as possible to the ecosystems that would result from natural disturbances, and that incorporate the spatial, temporal, and random variability intrinsic to natural systems* (from Perera and Buse, in press). Based on this definition, the scale of possible management approaches associated with emulating natural disturbance ranges from just using disturbance outcomes as a general guide for management to letting natural disturbances proceed without intervention.

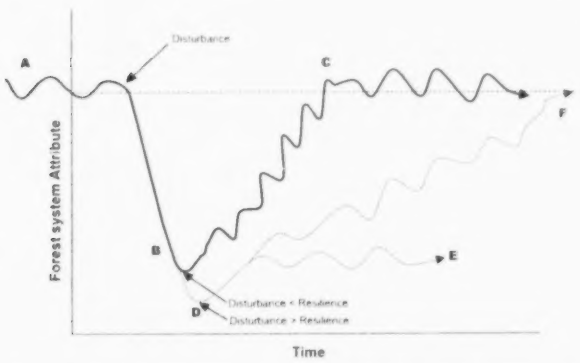

Figure 1. *A conceptual illustration of how a forest ecosystem might respond to disturbance (from Perera and Buse, in press).*

How could natural disturbance be emulated?

By understanding natural disturbances

To successfully emulate natural disturbance requires a sound understanding of the natural disturbances common to the managed landscape (e.g., type of disturbance, its spatial and temporal scale, its frequency and intensity, and its interactions with other disturbances).

By adopting a template

Forest practitioners need to adopt a disturbance template as a guide for emulating natural disturbance by forest management. Following are examples of potential templates (as described in Perera et al., in press).

1. The landscape pattern created by the *last* major disturbance. In this approach managers attempt to recreate the last known natural disturbance, implicitly assuming that natural disturbances are spatially and temporally constant, and will always create identical patterns.

2. Historical landscape pattern that has resulted from a *series* of previous natural disturbances (one common benchmark is the pre-European settlement period), assuming that the inferred

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landscape patterns are the net result of a series of prior natural disturbances, and that what *did* happen is a good indication of the intrinsic potential of natural disturbance regimes (i.e., of what *will* happen).

3. A broad temporal span of the historical evidence, following the same deductive logic as the previous one, but which captures the *variability* associated with disturbance regimes (known as the historical range of variability).

4. Historical templates derived through simulation modelling of historical scenarios. The philosophy resembles those of the first three approaches, but templates are constructed with inductive reasoning.

5. Spatially explicit simulation modelling of the *potential* natural disturbance regimes (i.e., modeling of scenarios). This inductive method differs from the other four in that it focuses on what *could* happen without referring to historical conditions. Although this approach has the disadvantages of being ethereal and abstract, simulating these scenarios has the advantages of capturing both the empirical and the mechanistic variability that are innate to natural disturbance regimes and of being spatially explicit.

By developing emulation criteria

Practitioners must develop a suite of emulation criteria to parallel the attributes of the selected disturbance(s) (Table 1). In doing this, it is critical that the management scale and disturbance attributes be matched appropriately and the effects or outcome of the disturbance(s) be carefully considered.

By clarifying management approach

Since ENFD will not replicate a natural disturbance, it is critical to clarify and match the extent and degree to which management will emulate disturbance with expectations; and communicate these clearly to all involved. For example, the proposed approach can be illustrated using an ordination diagram (Figure 2) to ensure that stakeholders are clear about the scale, criteria, and degree of planned ENFD.

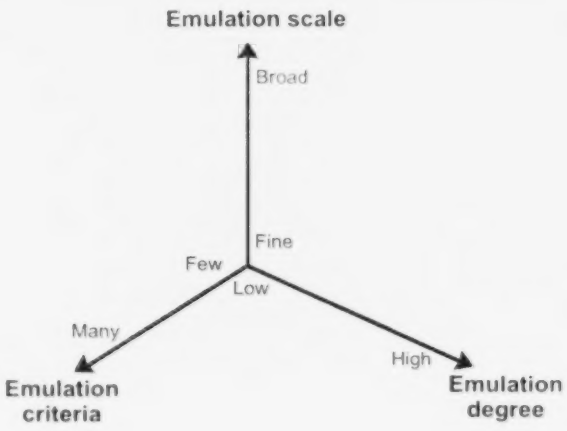

Figure 2. *A simplified ordination scheme for practices designed to emulate natural disturbance considering dimensions of scale, number of criteria, and degree (from Perera et al., in press).*

By monitoring outcome compared to disturbance in nature

As with any other management approach, in order to determine whether the planned outcome was accomplished and allow for future improvements the outcome of natural disturbance emulation must be monitored and evaluated. This involves deciding at the outset what system attributes will be monitored and how monitoring will be accomplished. For example, the outcomes of management decisions could be assessed based on the principles in Figure 1. Then the emulation scale, criteria, and degree would be adapted accordingly for future interventions.

What's left to ponder?

As with any emerging management paradigm, many questions remain to be answered. For example: Do we understand the disturbances? (E.g., do we understand the patterns and are we able to predict consequences in space and time? Do we know how different disturbances interact?); Are the goals and expectations of

Table 1. *Examples of disturbance attributes and emulation criteria for developing strategies that emulate natural disturbance (from Perera and Buse, in press).*

Nature of disturbance	• Overall rate of disturbance for a large region and its variation	• Fire-return interval, annual rate of defoliation
	• Spatial tendency of disturbance and its variation	• Spatial probability of wind damage, burns, floods
	• Temporal patterns in disturbance and its variation	• Interval between fires, insect epidemics, floods
	• Intensity of disturbance and its variation	• Severity of fire or defoliation and their spatial and temporal patterns
	• Geometry of disturbance	• Sizes, shapes, and adjacency of patches of disturbance
Consequences of disturbance	• Spatial and temporal patterns in landscape composition	• Patterns in residual vegetation, post-disturbance succession
	• Spatial and temporal patterns in landscape age structure	• Patterns in age-class distribution, species--age patterns
	• Ecological processes	• Nutrient, carbon, and hydrological dynamics

emulation clear to all stakeholders? (E.g., do they understand the potential outcomes of the proposed management approach? Can the goals be successfully communicated to all involved?); Is this approach socially acceptable? (E.g., is it compatible with cultural, aesthetic and other values? Is it acceptable to emulate nature through management?); Is this approach economically feasible? (E.g., how will this approach affect short and long-term timber supply? Is it cost-effective relative to current management practices?)

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Notes

BFOLDS — A Spatially Explicit Stochastic Model to Simulate Boreal Forest Landscape Dynamics

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There is an ever increasing need to study the large-scale fire regimes and subsequent forest cover changes in the boreal forest biome. This knowledge is critical to understand the possible effects of climate change, comprehend the role of forests in carbon sequestration, and develop sustainable forest management plans for boreal forests. In this context, we developed a scenario simulation model (Boreal FOrest Landscape Dynamics Simulator - BFOLDS) to characterize and predict large-scale forest fire regime and forest cover dynamics in Ontario's boreal biome. This model's development was especially motivated by the growing need to characterize and understand the potential fire-landscape dynamics for policy formulation in Ontario (Churcher *et al.* 2003, this compendium).

BFOLDS is a grid-based spatially explicit model, which uses georeferenced data for input (e.g., forest cover, climate, terrain), encapsulates spatial interactions within the model's functions, and produces georeferenced outputs (e.g., age, species). It explicitly scales the model functions (e.g., fire spread in 100-m steps determined by weather that changes at 1-h intervals), and accounts for spatial processes (e.g., fire spread is based on neighbourhood functions and it spatially biases forest succession based on geoclimatic variables). BFOLDS is also stochastic (e.g., accounting for probabilistic variation in processes such as fire ignition, spread, and extinction, and inputs, such as weather and fuel, and thereby predicts a probabilistic outcome). The model simulates the fire regime and fire-induced forest cover dynamics at broad spatial and temporal scales (more than 10 million ha and up to 300 yr), but uses a relatively fine spatial scale for some processes (1-ha spatial resolution).

BFOLDS contains two major modules: a forest fire regime simulator (FSM) and a vegetation transition simulator (VTM). The VTM operates on a fixed time step (1 yr), and the FSM operates on a variable time step (the time for fire fronts to propagate to the centres of adjacent 1-ha cells). If a 1-ha pixel burns with sufficiently high intensity in the FSM, the model assumes complete canopy destruction and the cell will subsequently be occupied by an appropriate tree species determined by the VTM. If a pixel does not burn, its forest cover may or may not be replaced based on the probability of succession in the VTM, with these probabilities based on a combination of age and site type. In both cases, the elapsed times since burning and since a species transition occurred are tracked separately in each year. Details of the model, including its architecture, simulation functions, input data structure, output information, and operating instructions, are provided in Perera et al. (2003), Yemshanov and Perera (2002), and Weaver and Perera (in press). Here we provide only a brief overview of the model based on Figure 1.

The FSM is process-based, and contains sub-modules for fire ignition, fire spread, and fire extinguishment. It represents the current state of knowledge of fire processes (e.g., influence of fuel, terrain, and weather on fire spread) rather than empirical data (e.g., mean fire size) and assumptions about the fire regime (e.g., size-class distribution of fires, mean annual proportion burned). We use Ontario fire and weather history databases for the past four decades (1963-2001), which contain the locations of lightning-caused fire ignitions, to "seed" fire ignitions in the model. The number of ignitions is selected randomly from a Poisson distribution, and the

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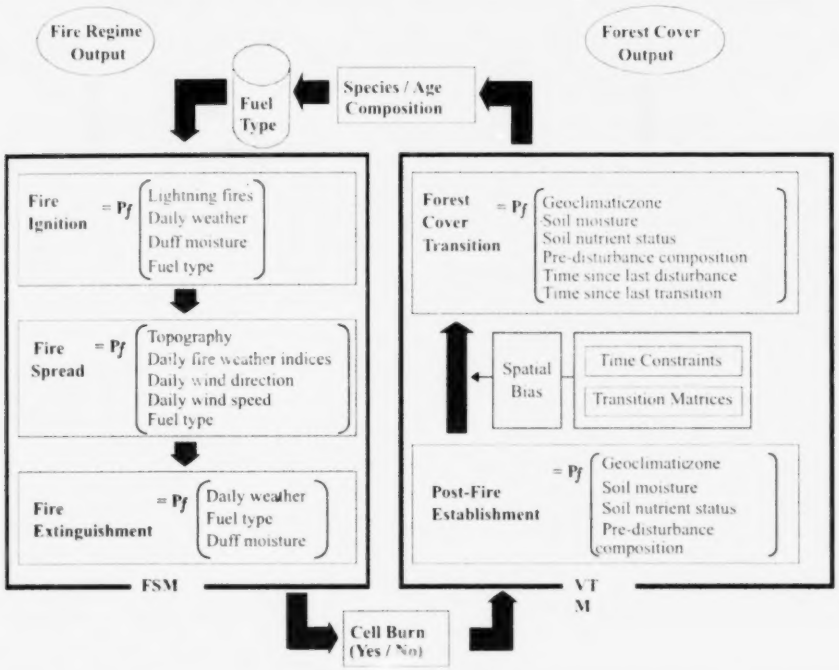

Figure 1. *Conceptual overview of the Boreal Forest Landscape Dynamics Simulator (BFOLDS), including the Fire Simulation Module (FSM) and the Vegetation Transition Module (VTM). P_f denotes that the probability of the outcome is a function of the stated variables.*

spatial positioning of these potential ignitions within the study area is also random. The actual ignition and subsequent spread of these fires result from the local weather patterns (simulated using daily fire weather data for the 1963—2001 period) and their interactions with the spatial patterns of fuel and terrain. The FSM uses cellular automata to simulate the processes of fire ignition, spread, and extinction based on the indices of the Canadian Forest Fire Weather Index System (Van Wagner 1987); these include the Fine Fuel Moisture Code, Duff Moisture Code, and Buildup Index, as well as wind speed, wind direction, and terrain characteristics. The model predicts fire intensity and rate of spread on an hourly basis when any fires are burning using the Canadian Forest Fire Behaviour Prediction System (Hirsch 1996). BFOLDS annually tracks the results of the fire simulation, for each 1-ha pixel separately, so that many aspects of the fire regime could be characterized spatially and temporally over the simulation period.

The VTM uses several raster GIS data layers that include forest cover composition and stand age, terrain, fuel type, time since last disturbance, and a suite of geoclimatic variables (Yemshanov and Perera 2002). This module contains two steps: post-disturbance recruitment of tree species, which is based on knowledge of the regeneration ecology of boreal tree species, and post-disturbance succession of the forest cover. The latter is simulated as a semi-Markovian transition process that predicts succession of the forest cover based on the probability of the persistence of individual tree species in the canopy, the length of the post-disturbance period, and geoclimatic conditions, with discrete states corresponding to the dominant tree species. It contains 680 time-dependent transition matrices for 15 forest cover types, which are spatially stratified by geoclimate, soil moisture, and soil nutrient status. These forest cover transition matrices were computed based on an extensive review of published empirical studies on boreal forest succession (Yemshanov and Perera 2001; 2003). The VTM

Table 1. *Output variables from the Boreal Forest Landscape Dynamics Simulator (BFOLDS).*

Fire Regime	Forest Cover Patterns
Annual Statistics	*Annual Statistics*
Number of fires	Species composition*
Total area burned*	Canopy-age composition*
Spatial geometry of fires*	Site-age composition*
Size-class distribution of fires	Spatial geometry of forest cover*
Overall Statistics	*Overall Statistics*
Size-class distribution of fires*	Survivorship distribution
Temporal variation of number of fires	Temporal variation of canopy age
Temporal variation of total area burned	Temporal variation of site age
Spatial tendency of burns*	Spatial tendency of landscape aging (canopy)*
Fire return interval*	Spatial tendency of landscape aging (site)*
Spatial tendency of fire return interval*	Temporal variation of species composition*
Spatial geometry of fires*	Spatial tendency of species occurrence*
	Spatial tendency of species-age occurrence*

*Spatially explicit information

also contains a sub-module that applies a spatial bias to the transition probabilities used to predict the change in forest cover; to do so, the sub-module uses local spatial autocorrelation of environmental site conditions (Weaver and Perera, in press) to reduce the artificial spatial randomness introduced by Markov models. BFOLDS annually tracks the outcome of vegetation transition in each 1-ha pixel to characterize the spatial and temporal trends in forest cover dynamics over the simulation period.

This model is compiled in C++ and its input/output is closely linked with ARCGIS to facilitate data management, visualization, and analyses. The input data include the raster (1 ha) data of slope and aspect, geoclimatic zone, soil nutrient status, soil moisture, forest stand age, and forest cover composition; and point-source historical data on daily occurrence of fire ignitions, daily fire weather indices, and daily wind speed and direction. Table 1 illustrates a summary of the BFOLDS output for both fire regime and the forest cover dynamics over a simulation period. Further description of these parameters can be found in Perera *et al.* (2003, in this compendium).

In summary, we believe BFOLDS simulations will provide useful information to characterize the potential boreal fire regime and forest cover dynamics, starting with the existing forest cover and present-day climate—as if fires were allowed to ignite and spread without human interference.

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Notes

Characterizing Boreal Forest Landscape Disturbance Dynamics: Components of Bounds of Natural Variation

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Characterizing boreal forest landscape dynamics at large scales (large extents over long periods) is rapidly becoming a popular topic among researchers and forest practitioners alike, using methods that range from extrapolating historical evidence to scenario simulation modelling. Because of the non-deterministic properties of disturbance regimes and post-disturbance responses of landscapes, it is equally important to understand the inherent variability associated with landscape dynamics (Lertzman *et al.* 1998). Generally, this viability is referred to as 'bounds of natural variation' in disturbance dynamics (e.g., Ontario Ministry of Natural Resources 2002). The studies that attempt to understand disturbance dynamics via natural history techniques term it "historical range of variability" (e.g., Morgan et al. 1994).

There are three aspects to the variation associated with forest landscape dynamics: *spatial* variability, *temporal* variability, and *stochastic* variability. Any given landscape can be ordinated based on these three dimensions of its disturbance dynamics. *Spatial* variability describes the variation in disturbance dynamics from to place-to-place within a given landscape, and could be attributed to the geo-physical heterogeneity of that landscape. *Temporal* variability addresses variation in disturbance dynamics from year-to-year over a long time period that results from temporal trends in weather patterns and species. *Stochastic* variability is the variation that arises from the probabilistic nature (randomness and/or bias) of biological and physical processes that constitute forest landscape dynamics. While some estimates of spatial and temporal variability in disturbance dynamics may be gleaned from natural history studies, it is impossible to estimate stochastic variability, because historical evidence is just one example of many possible iterations. Scenario simulation modelling, if model functions are spatially explicit and stochastic (and an adequate number of replicates are run), offers a means to estimate the stochastic variability as well as spatial and temporal variability.

BFOLDS (Boreal FOrest Landscape Dynamics Simulator – as described in Perera *et al.* 2003 and Perera *et al.* in this compendium) is a spatially explicit and stochastic model designed to characterize boreal forest fire dynamics and forest cover dynamics. As we illustrate with the results of a case study from boreal Ontario,

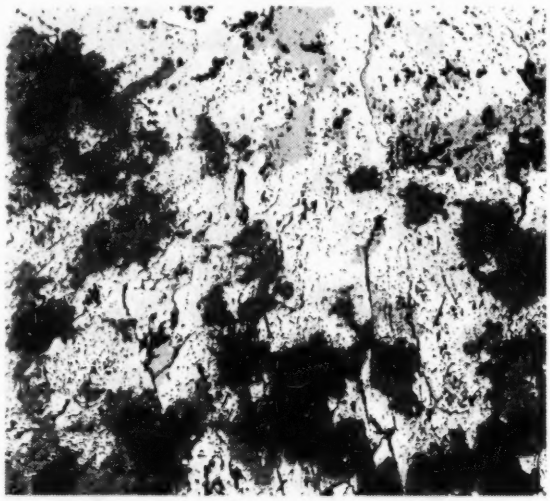

Figure 1. *Spatial probability of occurrence of a given (simulated) mean fire return interval in a forest landscape (at 1 ha resolution over a an area of 1.8 million ha). Darker colors indicate higher probability of occurrence and lighter colors a lower probability.*

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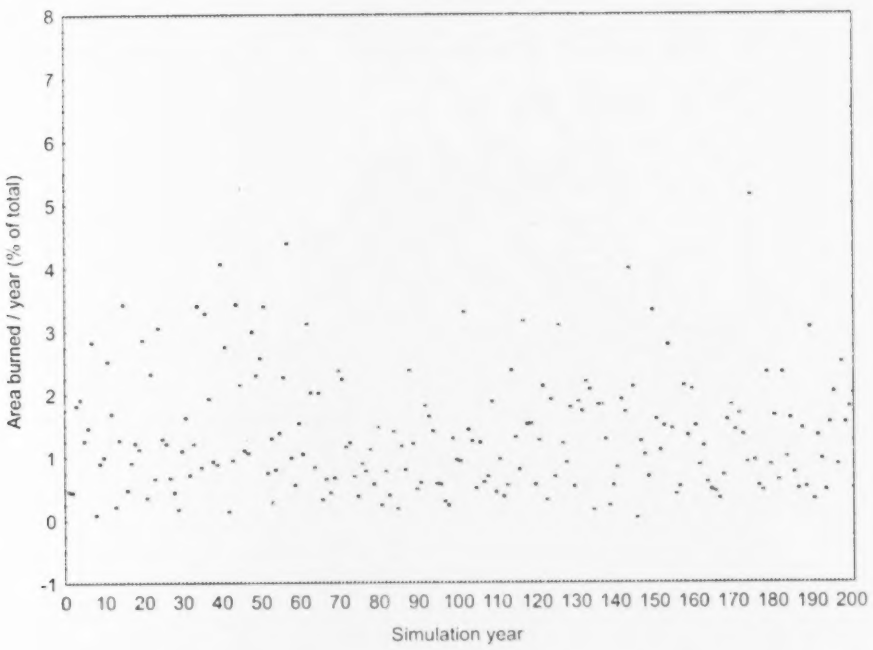

Figure 2. *Temporal variability in the mean annual area burned in a forest fire regime simulation run and the standard deviation of the mean estimates.*

BFOLDS can be used to explicate the 'bounds of natural variation' (BNV) and partition that variability into three sources: spatial, temporal, and prediction. Spatial variability can be presented as one numerical value for the landscape (e.g., standard deviation of mean fire return interval of the 1-ha pixels within the landscape) and portrayed as a choropleth map of spatial tendency (e.g., probability of occurrence of mean fire return interval of the 1-ha pixels within the landscape) as shown in Figure 1. Temporal variability can also be presented as one numerical value for the landscape (e.g., standard deviation of the mean annual area burned over the simulation period) and potrayed as a graph (e.g., annual variation in the mean are burned) as shown in Figure 2. The stochastic variability can be presented as the statistical variability around means on a graph (e.g., confidence interval of the mean annual area burned) and pixel means on a choropleth map (e.g., standard deviation of mean fire return interval) as shown in Figure 3. For details on the use of BFOLDS to understand variation associated with fire disturbance dynamics see Perera *et al.* 2003.

Moreover, the stochastic, temporal, and spatial variability can be combined and presented as spatial surfaces of probabilities (Figure 4). This information provides powerful insight to the 'bounds of variation' of natural disturbance dynamics in forest landscapes. As we have demonstrated, this knowledge is vital to the use of natural disturbance regimes as null models for emulating natural disturbances (Perera *et al.* in press a) and developing strategies for old growth forest supply (Perera *et al.* in press b). Every attempt in characterizing forest landscape disturbance regimes must incorporate clear, transparent and repeatable means of estimating these three sources of variability.

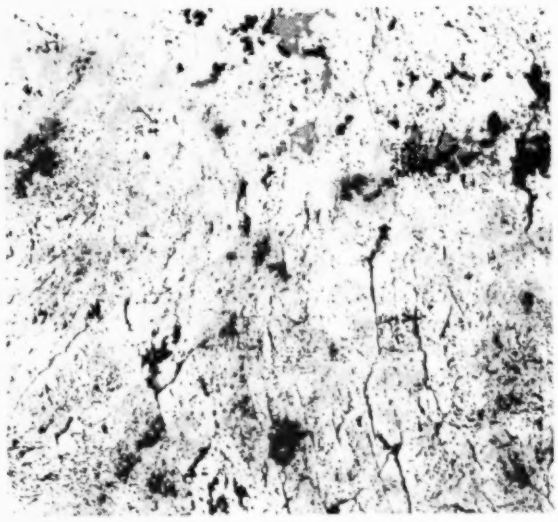

Figure 3. *Spatial distribution of the Confidence Interval (95%) of the simulated mean fire return interval in a forest landscape (at 1 ha resolution over a an area of 1.8 million ha). Darker colors indicate higher Confidence Interval, and lighter colors lower Confidence Interval.*

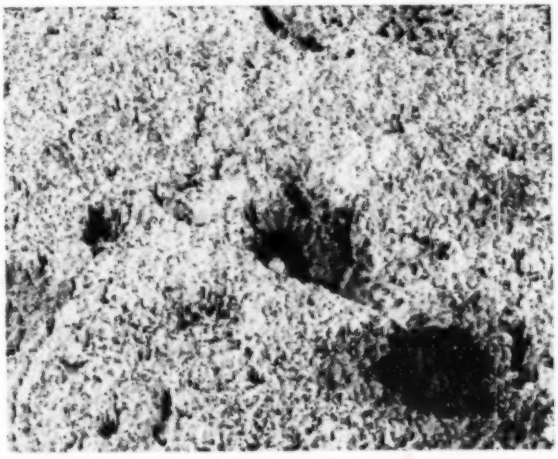

Figure 4. *Portrayal of the spatial, temporal and stochastic variation in mean fire return interval al in a forest landscape (at 1 ha resolution over a an area of 1.8 million ha). Darker colors indicate higher temporal variation, and lighter colors lower temporal variation. The surface ruggedness is due to the changes in stochastic variation (valleys = lower stochastic variation, peaks = higher stochastic variation).*

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Notes

Effects of Soil Characteristics on Site-index and Development of Multiple Regression Equations for Tolerant Hardwood Forests in Central Ontario

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Introduction

The tolerant hardwood forests in Ontario have an important role in sustainable

forestry in that they are used to produce a variety of forest products including high quality lumber, while helping to maintain site quality, wildlife habitat, and biological diversity. Site quality evaluation, the integration of soil (fertility, drainage, texture, depth), climate (temperature, precipitation), topography (elevation, aspect, etc.) and other factors, is needed to make meaningful growth and yield forecasts (Vanclay 1994). Site index, the height of dominant and co-dominant trees at a reference age, is the most accepted method to measure site quality for a given species under the condition that height growth is not dependent on non-site factors such as suppression and damage due to diseases or insects (Spurr and Barnes 1980, Nigh 1996, Chen et. al 1998). In the absence of suitable trees, an alternative method for predicting site index is based on relationships between site index and environmental variables or foliar nutrients (Fralish 1994, Wang 1995).

In this study we collected data from 62 sample plots in mixed, uneven-aged sugar maple (*Acer saccharum* Marsh.), American beech (*Fagus grandifolia* Ehrh.), and red oak (*Quercus rubra* L.) stands located in central Ontario to investigate the relationships between site index and soil characteristics. Chemical and physical properties of soil including pH, the total amount of organic matter, N, P, the exchangeable cations Ca^{++}, Na^{+}, and K^{++}, and texture were measured for each "sample element" or "layer". Also, the percentage of coarse fragments, depth of root system, and bulk density were measured for each pit-soil sample. The objectives of this study are: (1) to determine the variability of soil characteristics in tolerant hardwood forests of central Ontario, (2) to investigate site-productivity relationships between site index and soil, and (3) to examine the precision of predicted site-indexes.

Approach

A total of 62 circular plots with a radius of 5.64 m (100 m2) were selected in Haliburton Forest, Algonquin Park, and the North Bay area of central Ontario. To represent all possible site qualities, the plots were subjectively stratified into good, medium, and poor with the help of Forest Resource Inventory and Forest Ecosystem Classification (FEC) maps, and local foresters' knowledge.

In each plot, elevation, latitude, and longitude were measured by GSP. Also FEC classification; site position such as crest, lower slope, or depression and slope percentage and aspect; surface rockiness; and list of tree species in order of abundance and list of shrub and ground species in each plot were mentioned. Three to 9 dominant or dominant and co-dominant trees, 50 years of age and without history of suppression, were felled for stem analysis to produce site indexes. Also 3 spots close to sample trees, representing the general condition of the site, were selected for soil sampling. From each recognized layer within each spot, one sample was collected and air dried. Then all samples were

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sieved through 2 mm sieve and the percentage of coarse fragments were measured. Organic matter content was determined by loss-on-ignition at 400°C. The pH in 2 matrixes of both 0.01 M CaCl2 and distilled water were determined potentiometrically using a pH meter on a 1:2 soil-solution suspension for the mineral soil and a 1:5 soil-solution suspension for the forest floor. The texture of identified horizons was determined using a hydrometer method. Two bulk density measurements of mineral layers were taken from 2 points located in each plot. After oven-drying at 105°C to a constant mass, their volume and the mass were determined. Concentration of cations including Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}, Al^{3+}, Fe^{3+} extractable was determined with 1 N ammonium chloride (NH_4Cl, pH 4.5) method. Total N as percentage was determined with colorometric (autoanalyzer) method. Available phosphorus was determined colorimetrically using the ascorbic acid reductant method on a Bray P-1 (dilute acid ammonium fluoride) extract.

Results

The presence of coarse fragments is useful for plant growth at some levels, since it increases penetration of water and air into the soil. However, by increasing the percentage of coarse fragments, the ability of soil to hold water and nutrients will be decreased. In addition, the coarse-textured materials can occupy significant volume of soil with little contribution to plant nutrition. Figure 1, as an example, shows a significant difference between good and poor sites with respect to the coarse fragment percentage of each layer. On good sites, the amount of coarse fragments in all layers is lower than that on poor sites. This difference is not obvious for medium sites mainly because the identification of site quality of plots was based on experts judgment in the field, not on site index. The boundaries between medium, good, and poor sites remain unclear pending the development of the site index curves. Data analysis is still in progress.

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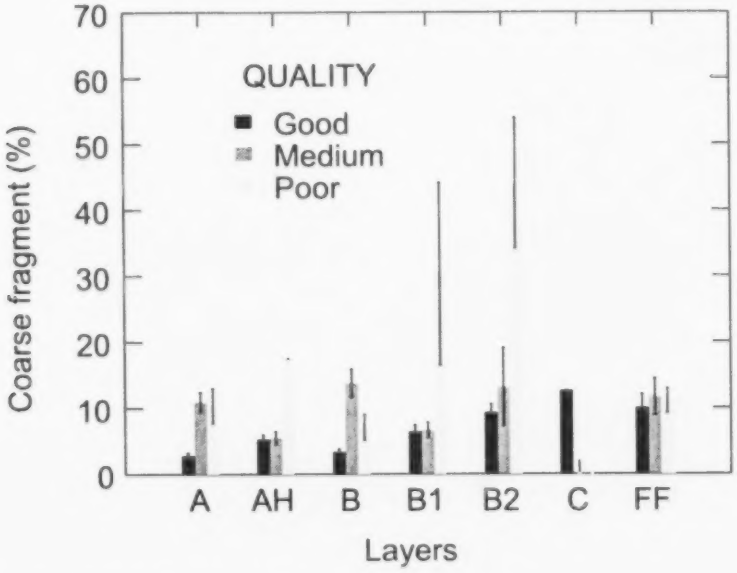

Figure 1. *Coarse fragment content of various soil layers for 3 site quality types.*

St. Marys Historical Forestry Spatial Database

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St. Marys Paper Ltd., formerly known as Abitibi Paper, has operated for over 100 years in northern Ontario. Thousands of documents have been kept in the attic of its main office in Sault Ste. Marie, Ontario. These papers include maps, photographs, ledgers, experimental growth plots, technical blueprints, construction drawings and records of boat, horse, and bush camp management. Many of these valuable documents had begun to degrade. The St. Marys Historical Forestry Spatial Database Project was developed to preserve and archive these papers for use by the resource management community and the public. These documents have been digitally scanned and integrated into a searchable spatial database.

The collection currently contains over 7,500 of the first aerial photographs of northeastern Ontario, approximately 20,000 pages of forest composition records, and over 7,000 maps and drawings dating back to 1861. Detailed records of forest cover and age classes by township or watershed are also included. These documents provide details of the original forest environment and evidence of the earliest efforts at sustainable forestry management in northern Ontario.

The information in the documents mainly pertains to the region from Marathon on the north shore of Lake Superior, east to Sturgeon Falls, south to the North Shore of Lake Huron and north to Timmins and Iroquois Falls. The information ranges over an area (see Figure 1) that currently includes 25 provincial parks (not including island parks), 8 conservation areas, 9 proposed Ontario Living Legacy areas, a national park, and at least 2 designated historical sites.

The database is categorized into 6 broad topic areas: forestry, engineering, land tenure,

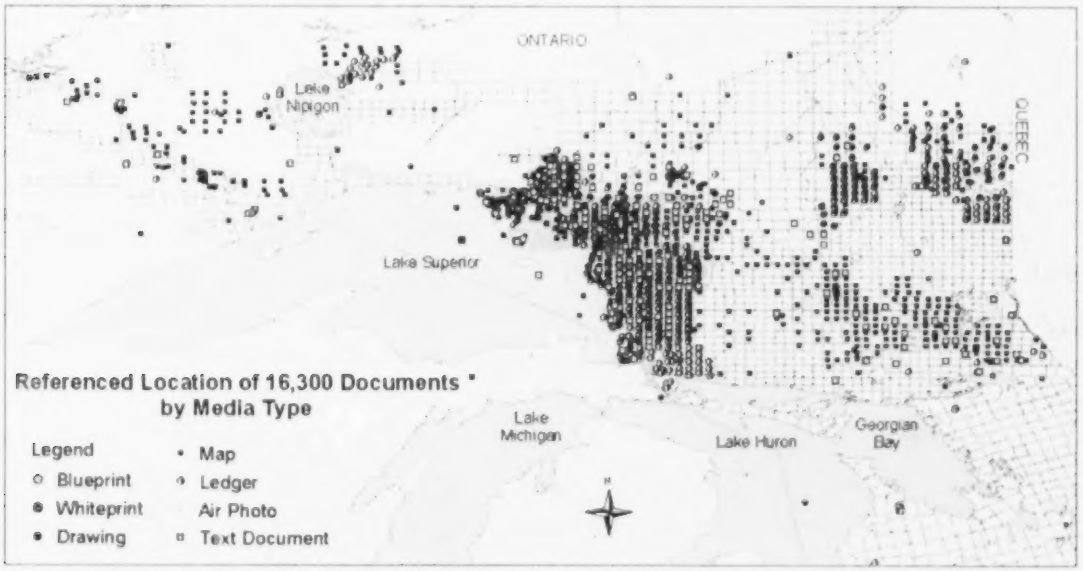

Figure 1. *Map illustrating the area of coverage of the St. Marys historical spatial database project.*

legislation, administration, and geography. Once cleaned, repaired and properly stored, documents are scanned and linked to a database record. Data associated with each record include spatial coordinates, tree species, dates, and keywords. Users are able to search the database by looking for a particular word, by date, by media type or combination of all these. The next step in the project is to make this database available via the Internet. Data will also be accessed by selecting a point or area on a regional map.

This unique collection contains a wealth of information relating to the original forest environment of the area. There are reports of observations on growth, species populations, and planting programs and there are records of the first forestry sustainable development programs initiated by the industry. Forest inventory and cutover maps date back to 1905 and denote the earliest tote roads and delineate forest fire areas as early as 1850. Many of the aerial photographs in the collection may not be available in other provincial or federal collections.

This collaborative, multi-agency project has been funded and sponsored by St. Marys Paper Ltd, Sault College of Applied Arts and Technology, Upper Lakes Environmental Research Network (ULERN), Human Resource Development Canada, Canada Foundation for Innovation, Ontario Innovation Trust, Natural Resources Canada – Canadian Forest Service, Sault Ste. Marie Public Library, and the Ontario Ministry of Natural Resources.

Carbon Sequestration Patterns in the Replanted Areas of the Sudbury Barrens

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Introduction

The Sudbury region of Ontario, Canada has had a long and successful history of mining and smelting, going back over the past 100 years. The economic success of these operations has come at a cost, for now this area is one of the most disturbed ecosystems in Canada and is an example of extreme human impact upon the environment. These activities, along with forest fires and logging, led to the creation of nearly 20,000 ha of completely barren land and another 80,000 ha of semi-barren landscape. These areas were highly eroded with the remaining soil pockets being highly acidified. Vegetation consisted of communities with very little trophic structure and few species.

Beginning in 1978 a large-scale program of repairing the industrial damage was initiated. Starting with liming and grassing of the barren areas, followed by replanting of mainly native coniferous tree species, this program has led to over seven million trees planted over 17,000 ha of the barren and semi-barren landscapes surrounding the Sudbury smelters.

As these replanted stands mature and grow they change the ecosystem from a barren almost tundra-like system to a forest system that hopefully resembles the natural ecology of the region. Along with providing positive changes in the ecosystem, such as slowing erosion, reducing runoff, lowering evaporation and serving as a nutrient and moisture sink, the replanting of these areas has altered the carbon sink patterns of the region. The growth of the trees, the formation of a litter and humus layer, and modification of the mineral soil layer would all suggest that carbon is accumulating across the region. This study was an attempt to gain some understanding of the current carbon sink patterns in the replanted areas of the Sudbury barrens. The study concentrated on areas planted with jack pine (*Pinus banksiana* Lamb.) and red pine (*Pinus resinosa* Ait.) since these have been planted throughout the restoration program, allowing consideration of temporal changes.

Materials and Methods

Fourteen study sites were selected within the Sudbury region. The sites had to meet a number of criteria: they had to occur on areas that were limed prior to planting, they had to have only been planted during 1 or at most 2 consecutive years, and they had to support primarily red or jack pine. Restoration sites were picked in 4 age categories of 9, 15 19 and 23 years since their establishment. Additionally, 3 non-reclaimed sites were sampled to establish a baseline for carbon levels. Of these 14 sites, 4 are located in the region surrounding the Falconbridge smelter (FRU), 5 sites are located in the area surrounding the former Coniston smelter (CONU) and 5 sites are located in the region surrounding the INCO Copper Cliff smelter (INCOU).

Sampling occurred during the summer and early fall of 2002. At each site 30 sample points were selected within the areas where tree planting had occurred. At each sample point a soil core was taken to a depth of 20 cm in the mineral soil using a copper pipe with an interior diameter of 3.8 cm. At the same time, organic soil layers were collected using a 25 x 25 cm frame. Organic matter concentration was determined using the loss on ignition (LOI) method. Carbon concentration for the organic and mineral soil layers was then estimated by multiplying the OM concentration by 0.5.

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At each site the point quarter method was used to gather diameter at breast height and height measurements for overstory level vegetation and to calculate stand density. These data were converted to aboveground biomass measurements using applicable biomass equations. Carbon concentration was estimated at 48% based on other studies. Belowground biomass for the overstory vegetation was estimated at 20% of aboveground biomass. Aboveground shrub biomass and herbaceous biomass was determined by 10 1 x 1 m or 25 x 25 cm plots per site, respectively. In each square the vegetation was clipped at the soil surface and weighed. Total shrub biomass was assumed to be 2.5 times the aboveground biomass, while herbaceous biomass was assumed to be 3 times aboveground biomass.

Results and Discussion

Overall estimates of the community carbon pools ranged from a high of 106.5 + 6.16 Mg C ha^{-1} at the oldest site (OS79) to a low of 35.54 ± 6.47 Mg C ha^{-1} at site CONU (Table 1). The mineral soil contributed the vast majority (91%) of the carbon to the community pool at site CONU and was the dominant component at all the non-reclaimed sites (FRU: 89%, INCOU: 85%). It remained the largest carbon contributor until it was replaced by the aboveground tree component at site OS79 contributing 29% and 49%, respectively. The combined tree carbon pool was at a maximum at site OS79 where it contributed 59% of the total pool. Of the planted sites FR93 had the lowest contribution by trees at only 4%.

Shrub and herbaceous layer contributions to the overall community carbon pool were variable across the sites. Herbaceous contributions were highest in the non-reclaimed sites where they ranged from 4% to 12.5% of the community pool and lowest at a 9 year old site (FR93) where they made up 0.1% of the carbon pool. Shrub contributions were highest at CONU, FR87 and BN87 all at 4.5%. This was in contrast with site BOR83 where no shrub layer was recorded.

The forest floor contributed between 6 and 16% to the total carbon pool in replanted sites with its largest contribution being at BN87. The 3 non-reclaimed sites all had no forest floor in their carbon pools.

Table 1. *Mean(± standard error) carbon content (Mg ha^{-1}) for tree level, shrub, herbaceous, forest floor and mineral soil components of the community carbon pol across the 14 Sudbury barrens sites.*

Site	Aboveground Tree	Belowground Tree	Shrub	Herb	Forest Floor	Mineral Soil	Total
CON79	52.36 ± 5.87	10.47 ± 1.17	0.51 ± 0.51	0.24 ± 0.17	12.37 ± 0.77	30.53 ± 1.09	106.5 ± 6.16
CON83	30.5 ± 2.65	6.1 ± 0.53	0.93 ± 0.46	0.49 ± 0.17	6.83 ± 0.54	28.30 ± 2.06	73.19 ± 3.47
FAL83	23.24 ± 2.52	4.65 ± 0.50	1.07 ± 0.41	1.25 ± 0.90	9.11 ± 0.62	33.68 ± 2.88	73.04 ± 4.03
INCO83a	28.19 ± 3.27	5.64 ± 0.65	1.43 ± 0.48	0.83 ± 0.19	11.77 ± 1.32	33.12 ± 2.90	81.04 ± 4.64
INCO83b	33.19 ± 2.57	6.64 ± 0.51	0.00	0.55 ± 0.36	12.36 ± 0.58	44.87 ± 2.52	97.60 ± 3.69
INCO87b	12.53 ± 1.24	2.51 ± 0.25	2.01 ± 0.64	1.39 ± 0.50	6.96 ± 0.61	39.07 ± 4.42	64.55 ± 4.71
FAL87	8.76 ± 0.87	1.75 ± 0.17	2.49 ± 0.98	0.65 ± 0.24	4.35 ± 0.56	37.83 ± 2.41	55.93 ± 2.82
INCO87b	12.35 ± 1.35	2.47 ± 0.27	2.52 ± 1.00	1.24 ± 0.45	8.92 ± 1.07	27.97 ± 2.51	55.58 ± 3.25
CON93a	6.75 ± 0.73	1.35 ± 0.15	1.5 ± 0.63	0.58 ± 0.17	3.71 ± 0.45	29.93 ± 2.01	43.88 ± 2.29
FAL93	1.68 ± 0.17	0.34 ± 0.03	1.24 ± 0.23	0.06 ± 0.06	3.24 ± 0.47	40.26 ± 2.58	46.87 ± 2.64
CON93b	10.53 ± 1.28	2.11 ± 0.26	0.84 ± 0.49	0.58 ± 0.13	2.79 ± 0.29	28.04 ± 3.36	44.92 ± 3.65
INCO0	0.07 ± 0.02	0.02 ± 0.01	0.76 ± 0.53	5.79 ± 2.31	0.00	39.44 ± 3.25	46.14 ± 4.02
FAL0	0.00	0	0.22 ± 0.11	4.58 ± 2.75	0.00	40.74 ± 2.92	45.54 ± 4.01
CON0	0.08 ± 0.01	0.02 ± 0.01	1.58 ± 0.55	1.42 ± 0.55	0.00	32.37 ± 6.42	35.54 ± 6.47

Note: Sites are named for the smelter they are located closest to. Numbers at end of site names represent year of planting, while sites ending in 0 represent non-replanted sites.

When examining the changes in the community carbon pool, above- and belowground tree biomass proves to be the main contributor to the carbon gains across the study sites, increasing at approximately 1.74 Mg ha^{-1} yr^{-1}. This dominance is line with other studies of afforested land. The total vegetative carbon pool was at its largest at site OS79 where it contributed 63.58 Mg C ha^{-1} of which 98.6% was in the tree component, and lowest at site FR93 where it was only 3.32 Mg C ha^{-1} (60.83% from tree level vegetation). The vegetative carbon pool was significantly correlated with the age of the stand (0.921) and this was mainly due to the influence of the tree level vegetation which was even more closely correlated at 0.962.

It was expected that both the shrub layer and the herbaceous layer would decrease in mass with increasing stand age. This would be a result of the canopy closing, which typically reduces understory productivity. The shrub layer however, did not significantly correlate with stand age reaching its highest carbon values in the 15-year-old sites where they averaged 2.34 Mg C ha^{-1} or 16.5% of the vegetative pool. This may be a result of the relatively young age of most of the sites and variability in stand density. The herbaceous level, while it was not significantly correlated to age, did have a significant negative correlation with the tree component, at -0.543, which is closely tied to age. The herbaceous layer was the major contributor to the vegetative pool at the non-reclaimed sites, where it made up between 46% and 95.5% of the pool. It also made substantial contributions to some of the mid-aged replanted sites, FRR87 at 9% and BN87at 8% of the vegetative carbon pool and one 19yr old site, FR83, also had a substantial herbaceous layer contribution of 5%. These sites also tended to be low planting density sites.

The top 20 cm of the mineral soil layer did not show any pattern in its organic carbon content in relation to the age of the site since replanting. This lack of an age specific pattern in the mineral soil carbon measurements was not particularly surprising, because of the history of the region and is reflected in the soil properties, where low bulk density or shallow soil often offsets high carbon concentration. Most of the sites examined have experienced large amounts of erosion. This has resulted in soil being concentrated in pockets across the replanting sites. These pockets contain not only old carbon remaining form the former forest system but often have charcoal deposits left from the fires that afflicted the region. This makes soil conditions highly variable from site to site and comparisons between sites difficult. The site with the highest level of mineral soil carbon was BOR83 with 44.87 $\pm$ 2.52 Mg C ha^{-1}, the lowest soil carbon levels were found at site BN87 at 27.97 $\pm$ 2.51 Mg C ha^{-1}, the sites averaged 35.02 Mg C ha^{-1}. The Tukey's operation separated the mineral soil results into two groups with sites BOR83 and FR93 having significantly higher mineral soil carbon than sites CG93, CON83 and BN87, with all other sites falling into both groups (data not shown here). The mineral soil also did not show any significant correlation with any of the other site parameters.

The forest floor is the other component that is providing a significant sink for carbon across the study sites. The 23-year-old site had accumulated a forest floor component of 12.37 Mg C ha^{-1} reflecting a close correlation of forest floor carbon and stand age (0.948). The forest floor carbon levels were also highly correlated with tree carbon (0.875) and total aboveground vegetative carbon (0.869). The linear correlation performed between age of the planting and the accumulation of the forest floor layer shows a significant increase in forest floor carbon averaging 0.54 Mg C ha^{-1} yr^{-1}.

The link between age and litter accumulation was lost at one site in particular, CON83. At this site the litter layer was a lot smaller than what was expected for the biomass and age of the site. The reasons for this anomaly are unclear as there may be many contributing factors. Litter build-up is highly correlated to site conditions and the nutrient status of the soils. Additionally, this site also has lowest carbon concentration in the mineral soil layer at 1.53%.

While some studies have found that soil carbon increases over time following afforestation, our study did not support this. One problem is that many of these studies concentrate on the conversion of arable land to forest, which is unlike the Sudbury situation. It has also been theorized that the increase in carbon inputs to the mineral soil may be offset in Sudbury by the reestablishment of soil decomposers as site conditions improve. Detailed study of the decomposition potential at these reclaimed sites would be needed to answer these questions.

Conclusions

This study did show a general increase in the community carbon pool as replanted areas increase in age. While tree biomass was the major source of increasing carbon values, the forest floor was also a major component in the overall increasing trend. The shrub and the herbaceous layers were not major contributors to the increasing carbon stock and tended to decrease over time. The mineral soil carbon pool proved highly variable across the Sudbury region because of heterogeneous site conditions, and no age-related trend was apparent. If an age effect is occurring, detailed long-term studies may be needed to describe it.

Notes

The Forest Information Portal: A Model For Government-to-Business Exchange of Forest Information

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Introduction/Objectives

Reliable and accurate information is crucial to the sustainable management of Ontario's forests. Having the right information in the right place at the right time is critical to supporting the decisionmaking process and meeting management objectives.

Creating and managing forest information in Ontario is a shared responsibility between the Ontario Ministry of Natural Resources (MNR) and the forest industry. An objective of this partnership is to streamline and improve the processes, policies, and procedures regulating the exchange and provision of information. In some cases, information exchange had become inefficient, inconsistent, and was lacking standards or schedules. Improvements over the past few years, in concert with a changing business relationship between government and industry, has led to a clearer description of the information requirements and a standardization of the products. The Forest Information Portal was jointly conceived and developed to assist in information exchange between the partners.

An Ontario government-wide focus on improving electronic delivery of services to clients and partners has made obvious the need for infrastructure improvements to support enhanced information management practices. The MNR's Forest Program has been a leader in delivering on improved customer services through the application of information technology. The most recent advancement is the Forest Information Portal.

The Forest Information Portal is a single-window, web-based interface for data exchange and sharing. The Portal will provide the forest industry with access to land related geospatial data, timber volume and revenue data, compliance monitoring information, and other data and information related to managing forests. It will allow the MNR to efficiently receive, verify and process data related to crown forests. It will also serve to meet additional requirements associated with data archiving and knowledge management.

Approach

Ontario's Crown-owned forests are divided into designated management units. Individual forest companies are licensed to manage a portion(s) of the Crown land forest area. The conditions of the licence include the development and submission of forest management plans and reports according to the Forest Management Planning Manual (FMPM) and the Forest Information Manual (FIM).

Planning for and achieving sustainable forest management requires the use of a broad range of information including administrative boundaries, forest resources inventories, infrastructure information, linear features, land ownership, land use, and forest values.

The MNR and the forest industry share responsibility for the creation and provision of information regulated under the FIM. A Joint Information Management Committee (JIMC), a committee of forest and information managers from industry and the MNR, were determined to build a solution to streamline and standardize the exchange of these regulated information requirements. Discussions at the JIMC table resulted in a conceptual single-window, user-friendly, efficient transfer mechanism — the

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Forest Information Portal concept was born.

The Forest Program of the MNR gave support and approval to a Business Solutions Services Forests work plan to build the Portal and support implementation of the Forest Information Manual. An external consultant led a user-requirements definition, analysis, and logical design process, which culminated in the development of a prototype portal. An extensive review and demonstration of the prototype was undertaken to finalize and confirm user requirements. Following application development, the MNR led user acceptance testing with participation from MNR field staff and industry staff on an Industry Technical Team.

Portal training was delivered by the MNR to Portal Account Managers. Account management is distributed with all designated management units having both a government and forest industry Account Manager.

Portal users require only a web browser and a small third party data transfer application. Downloads and uploads may be scheduled to minimize loads on networks and to manage transfers in areas with slow line speeds or unreliable power supply.

Results and Discussion

MNR and forest industry in Ontario use and maintain a variety of data, tools, and information systems. Some systems are proprietary and are tailored to meet specific business needs. The complexity of the systems and the capacity of individual organizations to use and support information systems varies greatly across Ontario.

To overcome the variety and system-dependent nature of the data managed by the OMNR and industry, the two parties agreed to a single, simple data exchange format. This format will permit the continued use of these internal information systems while facilitating data exchange and sharing. Conversion routines and processes will be required.

Authorized forest industry users of the Portal can request forest management-related data/information from various MNR corporate systems and data repositories. The Portal will also support the submission of data/information from the forest industry to the MNR, such as Annual Reports, wood measurement information, compliance information, maps and spatial data updates.

The Forest Information Portal v1.0., launched April 2003, includes functionality for:

- Product Submission
- Account Request
- Administration
- Product Validation
- Task List
- Job Status

Future versions will include:

- Product Request
- Information Forum
- Search
- Reports
- FAQ
- Enhancements
- Automated Validation Routines

Conclusion

Benefits to the forest industry in using the Forest Information Portal include a single, consistent location for exchanging information with the OMNR, and coordinated access to forest management related data and information.

Benefits to the MNR in using the Portal include automated validation of required, standardized information products received from forest industry, and streamlined data routing/access within the provincial organization.

Benefits to all partners, and to the people of Ontario, include on-line tracking of the status of data requests and submissions, archiving of all information passing through the Portal, and efficient dissemination and sharing of information in support of adaptive forest management.

The Forest Information Portal, an integral component of electronic service delivery, aims to improve customer service and enhance partnerships. As the Portal evolves and expands both in scope and functionality, it could serve as a model for other programs and clients.

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